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Monthly

Bulletin of the International Railway Congress Association

(English Edition)

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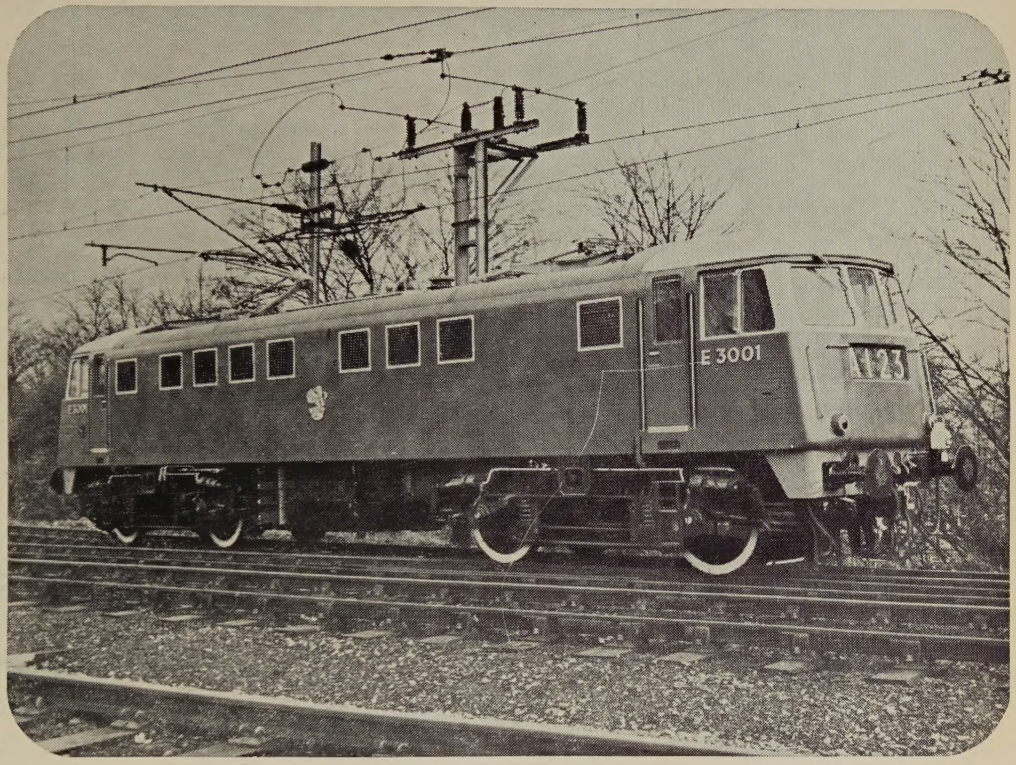

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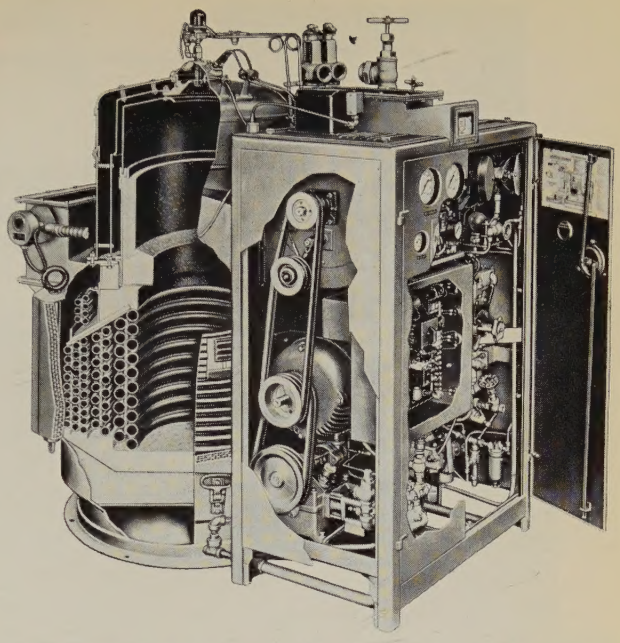

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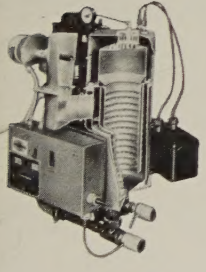

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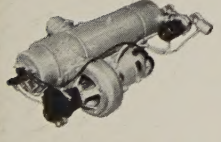

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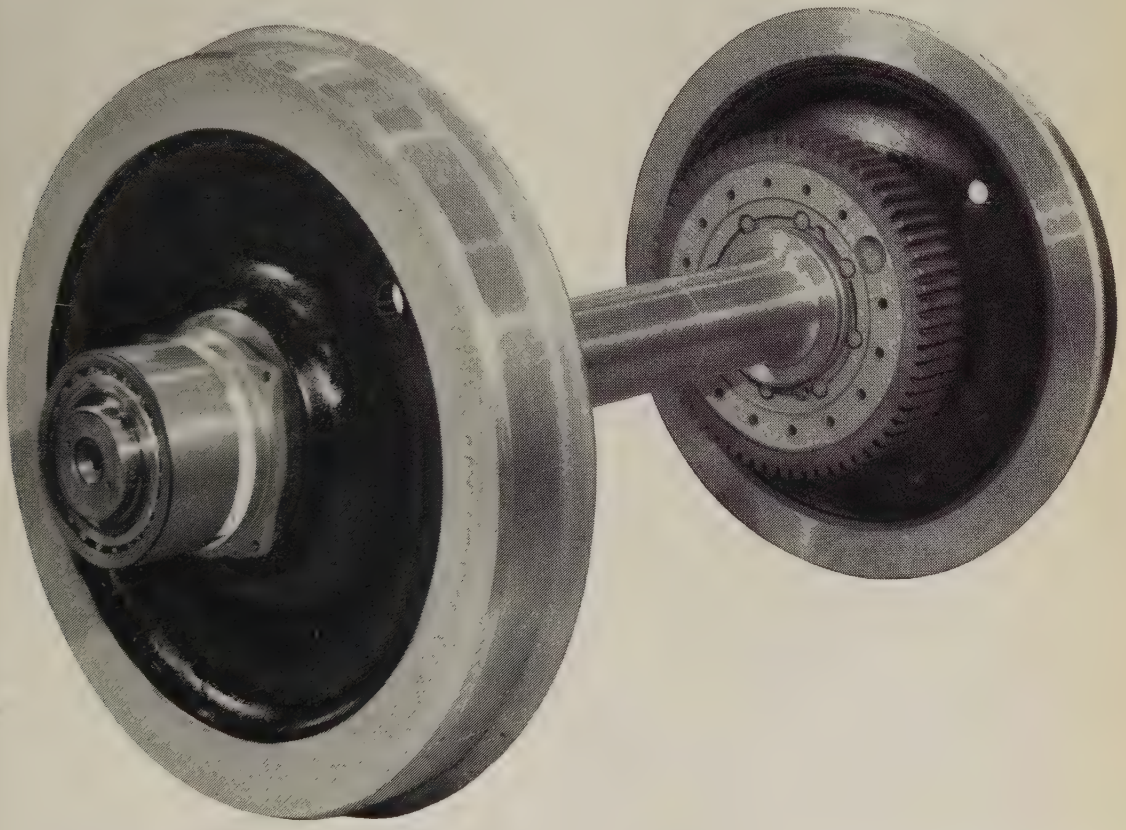

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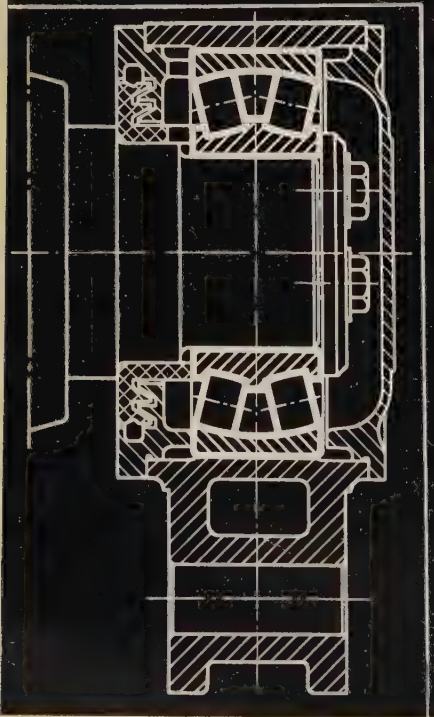

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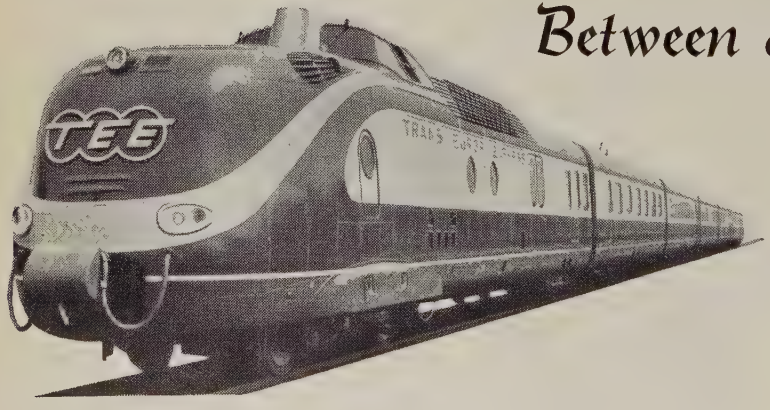

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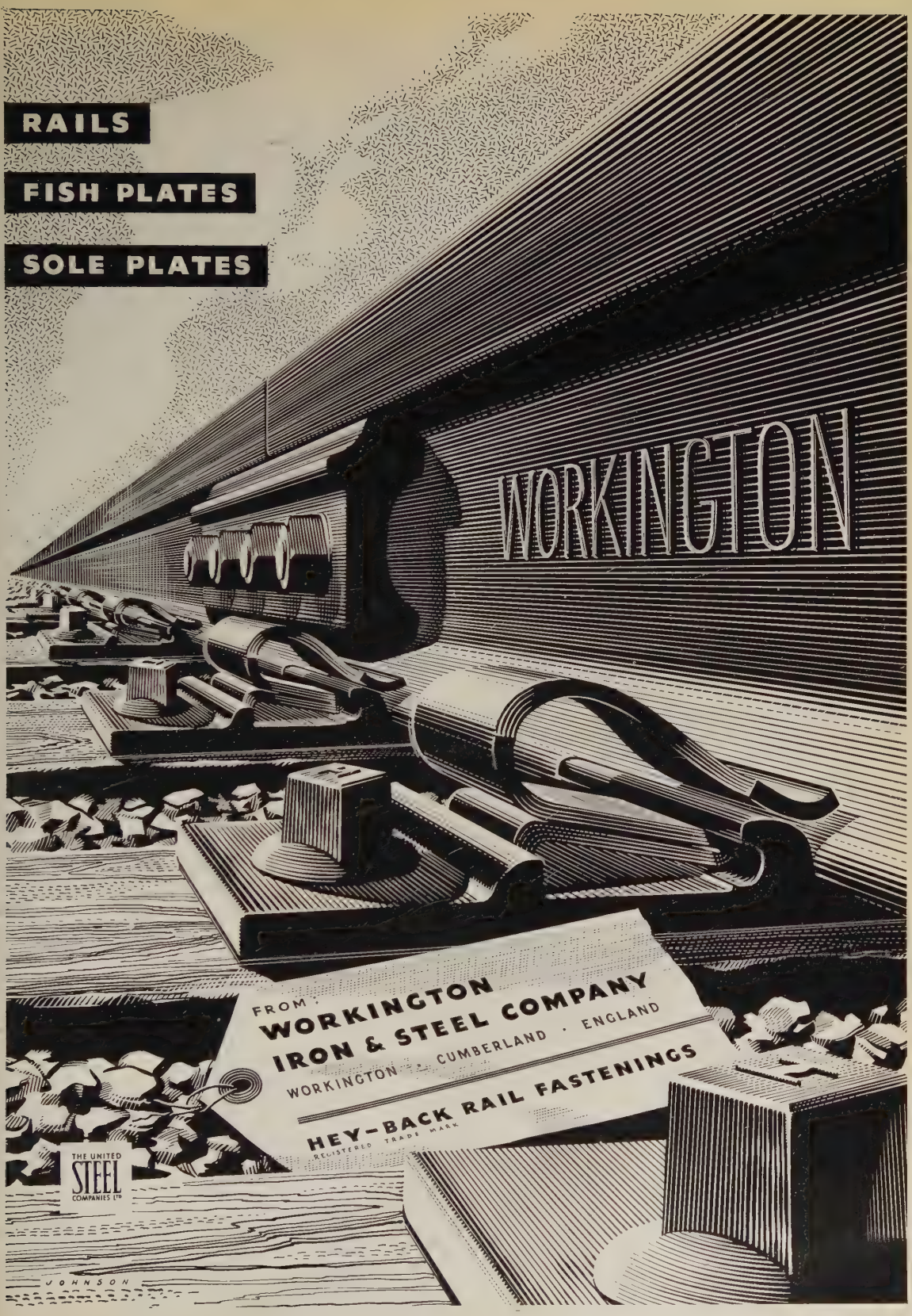
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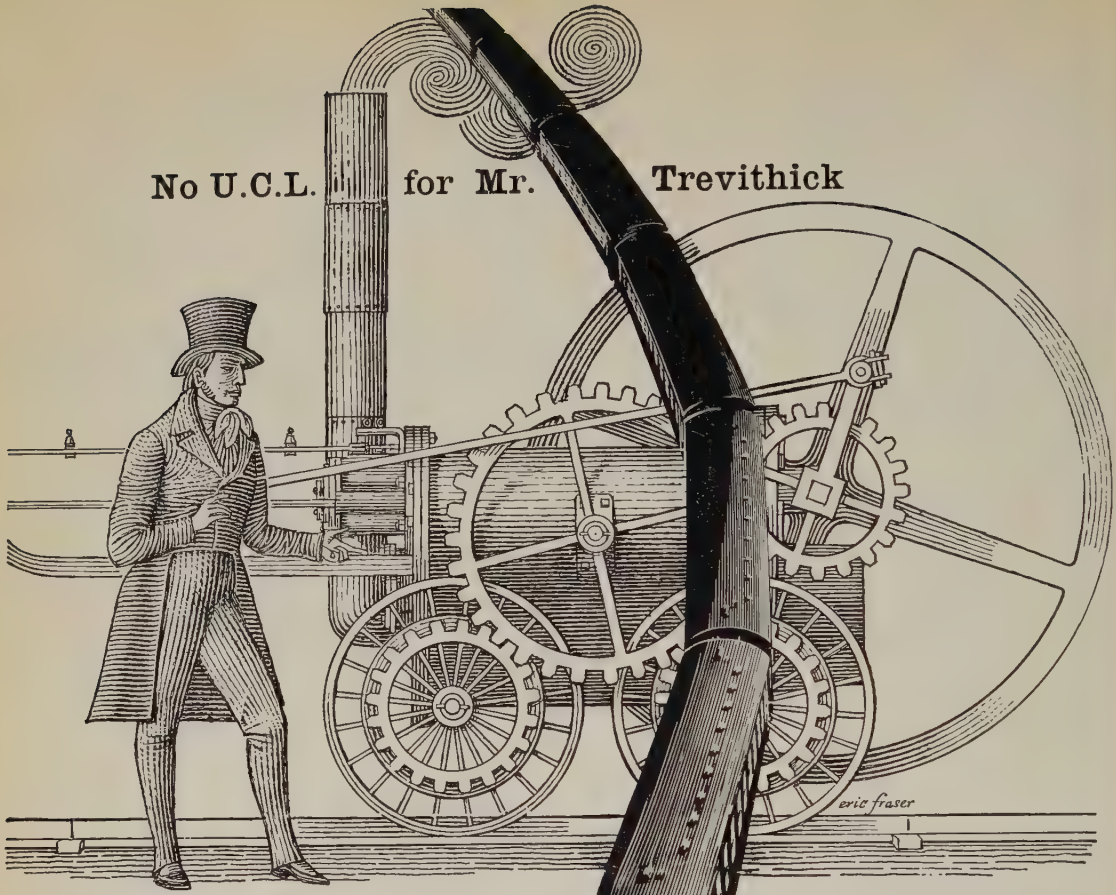

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Permanent Commission of the International Railway Congress Association

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An edition in French is also published.

Vol. XXXVII. — No. 6. June 1960.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

SPECIAL ACCOUNTS

summing up the reports on the questions for discussion at the Enlarged Meeting of the Permanent Commission. (Brussels, 1960).

SECTION I : Way and Works.

[656 .25]

QUESTION 1.

The effect of electric traction on signalling and communication circuits, in particular reference to the means of overcoming interference, to provide safety and good communications.

SPECIAL REPORT,

by Prof. Dr. Eng. R. Righi,

Directeur de l'Institut Expérimental des Chemins de fer de l'Etat Italien, Rome.

This question was covered by the two following reports :

Report : (America (North and South), Australia, Burma, Ceylon, Egypt, Ghana, India, Irak, Iran, Republic of Ireland, Japan, Malaysia, Netherlands, New Zealand, Norway, Pakistan, Phillipines, South Africa, Sudan, Sweden, Union of Socialist Soviet Republics, United Kingdom of Great Britain and Northern Ireland and dependent overseas territories and Uruguay), by Sven Svensson and J. A. Broughall. (See *Bulletin* for April 1960, p. 337.)

Report : (Austria, Belgium and Belgian Congo, Bulgaria, Cambodia, Czechoslovakia, Denmark, Ethiopia, Finland, France and French Union, West Germany, Greece, Hungary, Indonesia, Italy, Lebanon, Luxemburg, Poland, Portugal and overseas territories, Rumania, Siam, Spain, Switzerland, Syria, Turkey, Viet-Nam and Yugoslavia), by R. Righi. (See *Bulletin* for May 1960, p. 419.)

Addendum to Report, by R. Righi. (See p. 540 of this *Bulletin*.)

INTRODUCTION.

The purpose of the very detailed questionnaire which had been circulated was to elucidate the various aspects of the problems which the railway engineers are cal-

led upon to solve in order to attain maximum safety and to ensure reliable working of the telecommunications and signalling installations with regard to interference phenomena caused by electric traction installations.

It is well known that, in solving these problems, as well as in any question of interference, it is necessary to consider the two sides of the question, viz., on the one hand, the effects emanating from the traction installation and the way in which these interference effects can be minimized on the traction side, and on the other hand, the means apt to reduce, if not to eliminate, the harmful effects of these phenomena on the telecommunications and signalling installations themselves.

Thus, in order to obtain a solution satisfactory from the technical as well as the economic point of view, the problem calls for close liaison and cooperation between the engineers of the two branches concerned, and for a fairly precise knowledge, on the part of the engineers of each branch, of the problems and techniques encountered in the other branch.

For that reason, deriving inspiration from the working method adopted, for a long time already, by organisations dealing with similar problems, and in order to provide the fullest possible overall picture of the subject, the questionnaire circulated to the different administrations consisted of three distinct parts.

The first part, « Traction », dealt with the different electric traction systems used by the railway networks, and with the conditions giving rise to interference effects, without forgetting the devices of the traction systems themselves, designed to reduce these effects.

The second part was concerned with the position in relation to the railway line, with the structure, and with the electric characteristics of the overhead and cabled conductors of the telecommunication and signalling circuits which represent the coupling between the two sides.

The third part was concerned with the telecommunications and signalling installations themselves, and with the special problems which it was necessary to solve in order to ensure, in view of the effects emanating from the traction installations, such working of the telecommunications and signalling installations that any danger to the maintenance staff dealing with these installations is eliminated, and any trouble, if not wholly eliminated, is at least reduced to a minimum both under normal operating conditions of the traction system, and on occasions when the latter is affected by trouble (overcurrents, conductor earth, short-circuits, etc.).

The replies received, which are analysed and discussed in the two reports by Messrs. BROUGHALL and SVENSSON on the one hand and the author of the present report on the other hand, provide a very interesting overall picture, which should be very useful to railway engineers, especially in such a complex question as that covered by the questionnaire.

There is also reason to think that the conclusions and the data referred to above might represent a useful and welcome contribution, especially as regards the questions which are still controversial.

And those Railway Administrations which, being in the course of electrifying their networks, should be most interested in the question will no doubt be able to find in these reports and in the conclusions which can be derived from them the points of departure for their own research work on those questions which have not yet been studied to the full.

TRACTION SYSTEMS.

With any traction system, a distinction can be made as far as fixed installations are concerned, between :

— power supply,
— substations, and
— catenary.

That is why three sub-chapters are provided in the questionnaire.

In the study of a traction system as a whole, it is, however, not possible to disregard all the questions concerned with the types and power rating of the locomotives used, or with the traffic intensity on the lines.

A great part of the data have found their place in the very detailed tables which accompany the two reports so that it would hardly seem necessary to comment on them.

On the other hand, some general remarks appear to be called for. We propose to begin with those pertaining to the power supply for the traction networks.

POWER SUPPLY.

First of all, an important distinction must be made between the traction systems where the power is wholly or largely supplied by the public supply networks, and those where the power is wholly or almost wholly supplied from special power stations, owned by the railway.

It cannot be claimed that such a distinction is absolutely clear-cut, since several intermediate solutions are possible, and are in fact fairly frequently encountered.

It is nearly always the D.C. traction systems or the A.C. systems at industrial frequency which belong to the first category, whilst the systems with special frequencies mainly belong te the second category, with many intermediate solutions depending on the part played in the system by the frequency conversion installations.

As far as the D.C. electrified systems or the single-phase A.C. systems at industrial frequency are concerned, the reports show with remarkable conformity that, apart from certain special cases, the power absorbed by the railway installations is no more than a fairly small fraction of the power absorbed by the other consumers. There is thus no factual basis for any objections to the effect that, in the case of railway lines wholly or almost wholly taking their power from the public supply network, the latter may be adversely affected by the railway loads.

In the case of D.C. traction systems, it might be feared that the mercury vapour rectifiers installed in the convertor substations produce harmonics on the three-phase lines of the system.

In the case of single-phase systems working with industrial frequency, there might also be misgivings concerning the effects of a momentary unbalance of the load on the three phases. In practice, however, seeing that these loads are normally fairly small compared with other consumers, it is permissible to assume that the basic conditions applicable to industrial power supply lines are also fulfilled in the case of H.T. lines which supply railway networks, and that there is no need for regarding the latter as being different in principle.

In most cases where the power for the railway networks is supplied from the public supply network, there is no precise or obligatory relationship between the alignment of the H.T. lines feeding the substations, and the alignment of the electrified railways.

In the circumstances, the problems arising on the H.T. network feeding the substations do not differ from the problems generally encountered on industrial power supply lines.

In this connection, it is only possible to mention certain devices which are by no means specific to electrified railway systems but are encountered on any modern power supply network to ensure reliability of operation.

It is well known that, on H.T. supply networks with a voltage exceeding 100 kV, there is a growing tendency to connect the neutral direct to earth and to provide selective protection gear designed to disconnect, as rapidly as possible, the point where trouble is experienced (earth connection of a phase, etc.) so as to limit as far as possible the extent of that part of the network which must be disconnected.

It is likewise well known that reclosure devices are provided fairly often in order to ensure the early restoration of current in the case of merely momentary trouble.

This tendency is well borne out by the answers received; it exists everywhere, even if the introduction of such devices is delayed for economic reasons.

It can be foreseen, however, that these measures will be generally introduced sooner or later, and that this development cannot fail to improve the reliability of the working of electrified railways.

So far from being in any way detrimentally affected by these measures, the telecommunication installations, whether public or railway owned, can only benefit from the speed at which the abnormal conditions of the H.T. system are eliminated by these protective devices.

Even if one envisages the most unfavourable case of the earthing of a phase of the H.T. network at a point fairly close to the railway track, taking into account the very important values of the earth currents caused by the direct connection to earth, it is certain that the extreme speed at which the fault is cut out by the protective devices referred to above obviates any misgivings in this respect.

Other devices used by the supply networks (Petersen coils, neutral connected through a resistance), though not possessing the advantages of the devices referred to above, do not present any special problems concerning the railway telecommunications and signalling installations, and those interested in these questions can only be referred to the C.C.I.T.T. directives which are very precise, and which are the outcome of collaboration between the engineers of both branches.

In the case of the traction systems working with own power stations, with or without connections between the public supply network and the electrified railway system, the high tension lines and lines with current of special frequency running along the electrified tracks do not, either, present any particular problems concerning interference with the telecommunications and signalling installations. It can, in fact, be stated that the lower frequencies and the symmetry in relation to earth which are features of these lines can be regarded as wholly favourable.

SUBSTATIONS.

The questions relating to the substations are so numerous and variegated that their analysis, even if limited to the most important aspects, would risk being excessively long and uninteresting.

In the case of D.C. traction, most of the substations are nowadays equipped with mercury vapour rectifiers which have nearly everywhere replaced the rotary convertors. They are generally of the six-phase or twelve-phase type.

As is well known, an increase in the number of phases feeding the rectifiers gives rise to special advantages.

It is also well known that the frequencies of the harmonics are given by the expression $n.p.f$, where f is the network frequency, p the number of the phases feeding the rectifier, and n the order of the harmonics concerned. With twelve phases, the spacing of these frequencies is therefore twice as great as that encountered with six-phase rectifiers. Moreover, if p is doubled, the amplitude of a harmonic of the n^{th} order related to the mean value of the rectified voltage at no-load working, decreases very rapidly as p increases, and can be regarded as inversely proportional to the square of p. The value of the harmonics encountered with twelve-phase rectifiers is thus only about one-quarter of the value of the harmonics encountered with six-phase rectifiers.

The interest in limiting the value of the harmonics in order to reduce the interference effects has thus induced certain administrations to prefer twelve-phase rectifiers.

On the other hand, certain other administrations have deliberately adhered to six-phase rectifiers for reasons of simplicity.

The question whether or not filters should be used at the substation outlets to the catenary is controversial and has given rise to several different solutions.

Certain Administrations do not use filters in view of the fact, already mentioned, that the harmonics caused by twelve-phase rectifiers are very small. Other Administrations, even if they use six-phase rectifiers, do not envisage the need for filters because their telecommunication circuits are cabled and because their signalling installations (and especially the track circuits) are protected against any harmful effect of the harmonics.

Others again resort to periodic or aperiodic filters.

In general, it is possible to make a statement which, incidentally, also applies to numerous other problems discussed in the report mentioned above.

The application of a measure designed to reduce certain disturbing effects is basically a question of operation as well as economics. It is necessary to determine whether it is preferable to apply this measure, with its favourable effects, at the price of its higher first cost and other implications, or to solve the problem by special measures applied to the installations themselves which are liable to suffer from interference.

One can therefore only emphasize once more the need for a perfect understanding between the engineers of the two branches concerned, and for a complete examination of the entire question of interference.

All the Administrations are agreed that high-speed devices must be adopted for the protection of the feeders emanating from the substations. Admittedly, and this must not be overlooked, very rapid interruptions of the short-circuit currents are liable to give rise to important transient phenomena on the telecommunication lines. One might encounter very steep negative gradients which might even exceed, in absolute value, the positive gradients that appear at the moment at which the short-circuit currents are established. In modern technology, however, it is possible to find good compromise solutions.

On A.C. electrified lines, the substations are fairly frequently equipped merely with transformers of the simple single-phase type, connected between two phases, or in Scott connection. Where frequency conversion takes place at the substations, rotary sets are installed. Such an installation has, on the one hand, the advantage of a perfectly balanced load on the primary system; on the other hand, however, it tends to complicate the substation equipment. Such a solution, where the conversion takes place at several points, is more expensive, as far as the frequency conversion equipment is concerned, than a smaller number of conversion sets of higher power.

The question of unbalance and harmonics on the network in the case of the traction frequency being the same as that of the supply network has already been discussed, and we can only repeat the conclusion that there need not be any misgivings in this respect from a practical point of view.

Also in the case of A.C. traction the protection of the feeders emanating from the substations is effected by high-speed circuit breakers which are, in fairly numerous cases, also designed for a varying number of automatic reclosures.

The information provided in the answers to the questionnaire as regards the short circuit level at the substation input side does not permit of any general conclusions on this subject. There are obviously too many parameters entering into the picture, which are apt to vary greatly as between one network and another.

TRACTION SYSTEMS AND THEIR PECULIARITIES.

With D.C. systems, the substations generally work in parallel on the catenary. Sectioning posts are arranged in varying numbers between the substations. Their number depends on the working conditions and on the substation spacing. The latter, in turn, varies with the working voltage and with the traffic density : it is determined. inter alia, by technical and enconomic considerations.

On numerous railway networks, the two tracks are parallel connected so as to obtain the advantages inherent in this practice

(reduced voltage drops, reduced losses, etc.). More often than not, this parallel connection is obtained by means of automatic circuit breakers for the rapid location of earth faults.

In the case of A.C. traction working at special railway frequencies, the substations are nearly always parallel connected. In the case of railway lines electrified at industrial frequency, on the other hand, where the terminal substations are often fed from different phases, this only applies with certain qualifications. Fairly often, there is an isolating section at the mid-point between two substations, with a sectioning switch which is normaly open but which can be operated under abnormal working conditions (aerial operation). There are also circuit breakers which permit, in the case of double track lines, the parallel connection of the two catenaries, which has the advantage of reducing the voltage drops. The circuit breakers for the parallel connection of the two tracks are nearly always installed at the same point as the sectioning switches.

From the point of view in which we are more interested, viz. that of the interference phenomena due to the traction currents, one important question is that of the harmonics in the current which feeds the rectifier plants.

It has been established that the magnitude of the harmonics in the current flowing in the catenary, which gives rise to the most important interference effects, depends essentially on the extent to which the undulation of the rectified current feeding the traction motors can be admitted, taking into account the commutation difficulties caused by it, and the application of smoothing coils for the purpose of reducing it.

Unfortunately, there is as yet not official consensus of opinion on the ripple coefficients which can be admitted, and the answers received and analyzed in the reports do not provide a satisfactory basis in this respect. It is therefore desirable that the question should be thoroughly studied, and that it should be the subject of systematic tests where it would also be necessary to ascertain the effect of other factors which likewise have a bearing on the phenomenon, such as, in particular, the duration of the rectifier commutation, etc. As is well known, the frequency of these A.C. harmonics is generally $(np \pm 1)f$, hence for the catenary $(n \pm 1)f$.

As regards the value of the current used for the calculation of the interference phenomena, it may be recalled that, in the two cases of D.C. and A.C., respectively, numerous administrations have agreed on two methods for calculating the short circuit current and its interference effect; these methods, which are of very simple application, have been accepted, in principle, by C.C.I.T.T.

The method applicable to D.C. proposed and developed by the S.N.C.F. is based on the transient phenomenon due to the current gradient encountered on the occasion of a short circuit, replacing it by a permanent A.C. of a fictitious frequency determined on the strength of numerous test which were initially carried out by the S.N.C.F. themselves.

The verification subsequently carried out by the F.S. has resulted in a fictitious frequency value which differs but little from the figure found by the S.N.C.F. and which is of the order of 20 c/s. This method permits the study of the phenomenon on the basis of the well-known CARSON-POLLAGZEK formulas.

The method applicable to A.C. first studied by the C.F.F. (S.B.B.) and subsequently followed up by further research on the part of the S.N.C.F. can likewise be applied very easily as far as the calculation of the interference effects is concerned. After approval by C.C.I.T.T., this method will be the subject of a detailed description accompanied by numerical examples in a publication which should be very useful to railway engineers from a point of view of practical application. Whilst this method is based on the conventional notion of envisaging the phenomenon in the single-phase systems by considering two galvanically and inductively coupled loops, catenary-earth and rails-earth, the same publication will also bring

another method, proposed by Mr. Hofmann of the D.B., based on the consideration of the two loops, catenary-rails and rails-earth.

As far as the interference effects due to traction loads are concerned, the question presents itself in a fairly complex manner, and the replies received do not contain much information which would permit of general conclusions.

The C.C.I.T.T. rules on this subject, which were contained in the latest edition of their directives, are at present being revised. It is to be expected that the rule according to which the determination of the induction effects was governed by the current absorbed by two highly powered locomotives at the end of the section concerned, will be superseded by a rule more in keeping with reality. To judge by the latest discussions on this subject, the train frequency will be taken into account, i.e. the number of locomotives running simultaneously on the section concerned, on the assumption that these locomotives are regularly spaced between the substation and the end of the section. It may be noted that a principle of this kind, largely based on timetable data, is already used by many Administrations.

As far as soil resistivity is concerned, which also enters into the interference calculations, the information contained in the answers varies so greatly that it is not possible to derive from it any average values or valid conclusions.

The method most frequently used is that known as the method of four electrodes (two for the current, two for the voltage), introduced by Wenner; but this method calls for certain precautions if there are buried metal structures in the vicinity, and the results must be carefully scrutinised before they can be accepted. It is known that this value can be derived from the Carson-Pollaczek formula by introducing into it the known values given by the relation of the position of the two lines, and the variables measured during the tests.

It must be hoped that the work on a geological atlas recently discussed at the C.M.I. meetings will provide very shortly, at least for certain countries, more complete basic information which can be accepted with confidence.

COMPENSATING FACTORS.

As regards the current return through the rails, which plays such an important part in connection with the compensation of the interference effects, the data contained in the replies concerning the number of rails used, the connections between the rails of the same track, and the connections between the tracks of the same line are governed by the signalling system used and, in particular, by the presence or absence of track circuits, and by their length.

The use of electric bonding at the rail joints, which is indispensable for the track circuits of the automatic block system, can be viewed from a different angle where track circuits are absent and where traction and screening effect requirements are the only considerations to be taken into account.

On D.C. electrified lines, on the other hand, the requirements associated with the danger of stray currents lead to the use of very careful electrical bonding, generally welded to the rail joints. In recent specifications, the resistance value of these bonds is limited to that of 1 metre of rail used. The same requirements lead to the avoidance of any supplementary earthing of the rail so as not to increase the dispersion of the rail-earth current and the volume of the stray currents.

In the case of A.C. electrified lines, a highly controversial question is that of using booster transformers (also known as suction transformers), which are designed to increase the compensating effect of the rails by increasing the current flowing in them, or else to permit the realisation of a return conductor fairly close to the catenary, capable of providing a very important compensating effect and of reducing the current flowing in the rails. These are the two ways of using booster transformers without or with return conductor.

Opinions on this point are greatly divided.

With some Administrations, transformers have been used for a long time; other Administrations, after having studied the question thoroughly, have come to the conclusion that the use of such transformers is unnecessary; others again, having likewise studied the question, have decided to resort to transformers.

The question is very complex and depends, in any case, not only on the Railway Administrations but also on the arrangement of the installations belonging to other Administrations.

Even if the application of transformers has been decided upon in principle, there still arise many questions concerning the type and power of the transformers to be used; these factors play an important part. It must not be overlooked that the transformers are apt to give rise, to a certain extent, to a distortion of the current flowing in the catenary, and that they increase the losses and the voltage drop in the traction circuit.

These negative aspects are, however, not important enough to prevent the consideration of the use of this device for obtaining a compensating effect in certain cases.

Whether or not such transformers should be used can only be decided after considering numerous factors which have a bearing on the subject and which are apt to vary greatly as between one network and another, and after considering the general requirements and standards which are not always the same in different countries and which it would be futile to try to analyze here.

COUPLING.

RESULTING INTERFERENCE EFFECTS.

The information received in respect of the current flowing in the screening conductors, related to the currents on the traction line for normal load, maximum load and short circuit current, is not as complete as one might have expected. Among the comparatively few measurements taken, most give the modulus only, but not the phase angle.

It is, of course, necessary to appreciate all the difficulties of such research, caused by the numerous factors which govern the phenomenon and the screening effect. On the one hand, as far as the rails are concerned, there is the variation of the current as a function of the position of the load point in relation to the substation, the point at which the measurements are taken, the number of rails used for the return current, the insulation between rail and earth, the presence of other screening conductors (earth wires connecting the supporting structures of the catenary, and others), the reaction which the presence of these conductors is liable to have on the magnitude of the primary current, the way in which the other screening conductors are earthed over their whole length, the length of the extension of the rails beyond the section concerned, the resistivity of the soil.

Other variables, giving rise to further complications of the problem, are introduced by the presence or absence of booster transformers, their type and their installation arrangement.

That is why the information contained in the replies, and analyzed and assembled in the different tables, must be regarded as providing points of departure for new systematic tests rather than serving as a basis for conclusions.

ARRANGEMENT OF THE SIGNALLING AND TELECOMMUNICATION LINES, AND THEIR PROTECTION.

The telecommunications circuits, whilst contained in overhead lines or cables in the case of D.C. electrifications, are usually cabled in the case of A.C. electrifications.

Where overhead lines are used, the conventional rules of current transposition are usually followed, except that the number of transpositions may be increased in the most difficult cases. The distance of these over-

head lines from the catenary varies greatly and may, in certain cases, be reduced to no more than 3 metres; in other cases, a minimum distance of the order of 50 metres has been adopted so that the line is located outside railway territory.

As already mentioned, it is fairly rare to find overhead lines running parallel to A.C. catenaries; where this is the case, the distance from the catenary is considerable.

Earth return is hardly ever used, and only exceptionally for telegraph circuits.

The question of sensitivity coefficients has given rise to numerous replies but these are, unfortunately, not complete. The replies received in respect of the measured values are not provided on a statistical basis so that it is somewhat difficult to make use of these values.

No measurements have been reported of seasonal fluctuations of these values, but only of fluctuations during the day.

CABLES.

The use of cables for telecommunications and signalling circuits undoubtedly represents a solution yielding important advantages, especially from the point of view of protection against interference phenomena.

The questions to which the use of cables gives rise are numerous and range from the insulation of the core to the metallic sheath, the protection of this sheath and to the question of reinforcement.

In spite of the screening effect exerted by the metallic sheath and by the armouring, the longitudinal voltage induced in a cabled conductor of a certain length is liable to reach fairly high values. Although these screening effects can be improved to some extent by a suitable choice of materials, it must be emphasized (as discussed later on in greater detail) that, owing to the saturation of the magnetic material of the armouring which might result from the short circuit current of the traction installation, this reducing effect is liable to be impaired, and that fairly high induced voltages may occur in the conductors of the cable.

This gives rise to an important insulation problem which would call for the use of cables with fairly high test voltage compared with the maximum induced voltage to be expected, if an adequate safety margin is to be obtained.

One solution which has proved to be advantageous and which permits the use of telecommunication cables without special insulation features is the interruption of the telecommunication circuits at conveniently spaced points by means of 1/1 isolating transformers. As the longitudinal induced voltage is proportional to the length of section exposed, the reduction of this length obtained in this way permits an economic solution of these difficulties without resorting to cables with higher grade insulation. The incidental problems of verifying the insulation of the cable cores, arising from this interruption of the circuits, can be fairly easily solved, whilst the problems of the transmission of the signalling currents can be solved by using audio-frequency currents. These interruptions are arranged at intervals of the order of 20 kilometres.

Dry paper type insulation is the type of insulation most frequently used for the cores.

As far as the sheath is concerned, the question assumes a different aspect according to whether we are dealing with overhead or buried cables, and with D.C. or A.C. electrified lines.

If we confine ourselves to the case of buried cables, which is no doubt the case most frequently encountered, the most favourable reduction factor can, in principle, be obtained if the resistivity of the material of the sheath is reduced as much as possible, if the continuity of the metallic sheath is ensured in the best possible way, and if good earthing is provided. Owing to the corrosion problem encountered on D.C. electrified lines, it is first of all necessary to tackle the problem of the best corrosion resistance of the material, of its protection by means of an insulating layer superimposed on the sheath, and of the sectionalisation of the sheath itself.

If such measures are adopted, they undoubtedly give rise to less satisfactory conditions as far as the screening effect of the sheath is concerned, and this explains the preference for other measures taken in these cases, such as the use of filters or other devices designed to reduce the value of the harmonics in the catenary current.

In practice, it can only be confirmed that it is absolutely necessary to sectionalize the sheath at shorter or longer intervals in order to avoid the danger of corrosion, in view of the fact that nothing prevents the continuity of the sheath from being maintained, at least over a certain length, subject to the provision of an active protection by means of drainage or tapping : the direct currents thus set up between the sheath and the soil counteract the corrosive effects which would otherwise be caused by the stray currents.

It is also possible, even if the sheath is sectionalized, to re-establish the continuity of currents of fairly high frequency as well as for the harmonics of the rectified current through shunting the gaps by means of capacitances of suitable value.

On A.C. electrified lines, there is a tendency to replace the lead sheath by aluminium sheaths, which has the advantage of reducing the ohmic resistance. The metallic continuity of these sheaths does not give rise to any misgivings and is nearly always achieved, whether at the cable joints, at the gaps (if any) or at the cable heads at junctions and terminals.

The same applies to the armouring. As far as this part of the installation is concerned, which is so important to ensure a satisfactory screening effect for the cable conductors, it is possible to avoid the use of special magnetic materials of high permeability, which might have seemed necessary.

The use of such materials is liable to give rise to a marked increase in the cost of the cable, whilst the reducing effect would be seriously impaired by the saturation which would be encountered for relatively low traction current values so that the short-circuit current is already liable to meet less favourable protection conditions. It is preferable to limit the range of application to the descending part of the curve representing the reduction factor as a function of the current in the catenary.

An armouring consisting of ordinary steel tape is the one most frequently used.

SIGNALLING AND TELECOMMUNICATIONS.

As far as signalling installations are concerned, the most complex problems arise from the use of track circuits.

Since these circuits use the same rails which are also used for the traction return currents, there is reason to fear not only the effects of the direct action of the traction currents on the installations connected to the track but also, to a certain extent, the effects caused by magnetic induction or by electrostatic influence.

This type of trouble can assume great importance and calls for a profound knowledge of the problem on the part of the signalling expert, and for a judicious choice of the devices to be used.

On the other hand, no special or difficult problem arises in respect of danger to staff or harmful effects on the service life of the equipment.

As far as the track circuits are concerned, the possibility of magnetic induction effects which could no doubt arise from the lack of symmetry between the two lines of rails of one track in relation to the catenary of the adjacent track, cannot be excluded, no more than the same effects caused by currents flowing in the rails of the adjacent track.

Although these effects of magnetic induction are not likely to give rise to much trouble in practice, it would still seem desirable and useful to carry out systematic tests in this respect.

In any case, the possibility of direct and inductive effects gives rise, in the case of track circuits of fairly considerable length, to a problem of the electrical equilibrium of the two lines of rails in relation to earth.

This obviously applies also to the circuits with two insulated lines of rails which are equipped with inductive connections.

As far as track circuits in single rails are concerned, the maximum lengths permitted by the different Administrations differ considerably.

The great differences between these values can be understood if the different factors giving rise to the above-mentioned limitation are taken into account. Among them are, in particular, the value of the current in the rail to earth which, in its turn, varies with the number of rails in parallel connection, with the intensity of traffic, with the working voltage, etc.

However that may be, the application of single-rail track circuits is, in a sense, a compromise solution which is very often economic and interesting from a practical point of view, but which calls for the judicious use of devices designed to prevent the harmful effects which can be caused, in the first place, by the direct action of the traction currents.

If the track circuit always, in principle, poses the problem of avoiding, for safety reasons, the risk of the traction currents giving rise to abnormal conditions by energizing the track relay, or keeping it energized, when the circuit is occupied, there is, in the case of single-rail track circuits, also a strongly felt need for avoiding, in the interest of efficient working, the possibility of an untimely dropping of the relay. This problem which arises in a rather different form, gives rise to the greatly varying limitations mentioned above.

Undoubtedly, any solution capable of causing a reduction of the current in the rails makes it possible to obtain more advantageous conditions as far as the working of the track circuits is concerned.

Where the limitations referred to above prove to be too restrictive, the only possible solution, and the most complete solution, consists in using circuits with two insulated lines of rail with inductive connections and an A.C. feed for the track circuit.

The question of the current used for the track circuits must be treated differently on D.C. and A.C. electrified lines, respectively.

One general conclusion, valid in all cases, and well justified in principle, can be derived from the answers received : the type of current used for the track circuits must not be the same as that of the traction current.

On D.C. electrified lines, with the increasingly rare exception of certain very short circuits, the track circuits work with A.C.

On A.C. electrified lines, the track circuits may either work with D.C. or with A.C. of a frequency different from the fundamental frequency of the traction system and its most important harmonics.

With D.C. traction, the frequency used for the track circuits is more often than not the frequency of the industrial supply network, where a protection against the effects of the harmonics due to the rectifiers is provided by the use of induction relays with two elements (of the two-phase motor type, or disc type). Little importance is attached to the case of one rectifier anode becoming inactive since each section of the catenary is generally fed from two substations in parallel, i.e. by at least two rectifiers. There are, however, some Administrations that provide devices disconnecting the rectifier where one anode has become inactive.

The coding of the currents also provides good solutions to the problem in the case in question, but it also introduces certain complications.

Different methods, brought out by the two reports, are used to guard the single-rail track circuits against any untimely dropping of the relays when the circuits are free, due to the saturation effects caused by the D.C. traction currents (air gap type reception transformers, condensers, limiting resistances, bridge circuits, balancing impedances) or equilibrium impedances.

In the case of A.C. traction, the D.C. feed of the track circuits calls for suitable devices designed to protect the circuits against any effects of the traction currents; this is done by inserting series-connected inductive ele-

ments and resistive elements in parallel with the relay. Similar inductive elements are also fairly often provided on the feed side. Moreover, it is possible to render the relay practically insensitive to A.C. This solution is subject to a limitation because of the fact that the circuits can only be of the single-rail type, as the D.C. feed does not permit of the use of inductive connections.

If the track circuit has an A.C. supply, the problem is virtually reduced to selecting the frequency; there are thus several possibilities of guarding the track circuit against any effect of the traction currents. This choice can be made in several different ways, taking into account (and on this point, the replies are in good agreement) the fundamental frequency and its most important harmonics. On the strength of a spectrum of these frequencies, it is not difficult to choose the frequency of the track circuit feed in such a way as to avoid any coincidence and to obtain a sufficient safety margin to take account of the small variations which might give rise to a coincidence.

The relays might be of the induction type with two elements, which represents an excellent solution.

To-day, however, one solution which is being adopted more and more and which entails very important advantages is that originally introduced by the S.N.C.F. which consists in using audio-frequency circuits. This frequency can be far removed from the dangerous frequencies and can render the design of the oscillators and filters very easy and economic. In this case, there is no need for providing one or more centralised feeds, and feeders emanating from these for the feed of the track circuits. Individual feeder devices are used for the different track circuits which normally obtain their power from the supply network, with auxiliary devices acting in the case of a power cut. As the power absorbed is very small compared with conventional circuits, these devices can be kept very small and can very easily be realised. With the possibility of pulsating or coding these feeds by entirely static devices, one obtains an additional safety margin against the effects of the traction currents and, at the same time, an excellent means of solving the problems which arise in the case of a breakdown of the joints between adjacent circuits.

Another excellent solution consists in using track circuits with very short current impulses and high voltage, of the kind introduced by the S.N.C.F.; with this solution, the circuit is protected against harmful effects of the traction currents whilst reliable working is ensured even under difficult shuntage conditions caused by the existence of an oxide film on the rail head. This solution, too, is coming more and more into use.

All these solutions can also be applied at stations equipped for two or more traction systems where the problem is, in principle, the same except that the different traction feeds and the fundamental frequencies and their harmonics must be taken into account.

The problems of protecting the track circuits against overvoltages, from whatever source, are solved by providing discharge gaps connected between the two lines of rails and earth.

Signalling circuits other than track circuits do not give rise to any difficult problems. Since the length of most track circuits is limited, the induction effects are fairly often negligible. In any case, earth returns or permanent earth connections of a circuit conductor are avoided. Where the possibility of two abnormal and simultaneous earth leakages on the same circuit is taken into consideration, protection against any possibility of faulty working of the signalling circuit is obtained by an appropriate choice of its feed characteristics.

After what has been stated earlier on concerning the trouble which is liable to be caused to telecommunication circuits by the traction installations, a detailed examination of the question would not seem to be necessary. The particular solutions examined in the two reports are well in keeping with the exposition given above.

One may emphasize the fact that the measures taken by the Administrations are also designed to exclude all danger to per-

sonnel resulting from the phenomena which may arise in the circuits even on the occasion of abnormal contingencies on the traction system.

On the other hand, an important question is that of the repercussions, due to the electric traction installations, which might appear on the telecommunication circuits of the postal administrations, placed in the vicinity of the electrified track or making use of the cables placed along these tracks.

It would apparently be extremely difficult to try and pronounce principles of general validity, in view of the fact that the question depends greatly on the structure of the circuits of these Administrations and the systems which they use.

It is no doubt necessary that, in this matter, there should be close agreement between the Postal Administrations and the Railway Administrations in order to obtain the most advantageous coordination of the protective measures taken on both sides, in view of the national importance of the services entrusted to the two Administrations.

With such a well planned coordination, it will be possible to obtain the best solutions from a technical and economic point of view.

SUMMARIES.

1. It is the general opinion of the Administrations that interference between the substation power feeder lines and the telecommunications and signalling circuits does not present a special problem.

2. At D.C. substations, transformer- rectifier sets of the mercury vapour type are now in virtually general use. Most of the administrations use six-phase or twelve-phase rectifiers.

   Filters designed to reduce the harmonics are not often used with undulating currents.

   The equipment of A.C. substations depends on the frequency. The solutions adopted may comprise either transformers only, or rotary sets. In both cases, the feeders are protected by ultra-high-speed circuit breakers. Automatic reclosure is often used, with or without automatic earth tests.

3. The problem of interference phenomena between the traction contact lines and the telecommunication and signalling circuits (which are normally produced by magnetic induction, and measured by the voltage induced) has been the subject of calculation by several Administrations. As far as possible, the factors having a bearing on the subject and the effective current values for normal loads in case of short-circuits are being taken into account. With direct currents, in particular, the calculated or measured current gradients must be taken into consideration. The calculations are based on the formulas recommended by C.C.I.T.T. and, as regards the case of D.C. at the moment of a short-circuit, on the method of a short-circuit, on the method ef equivalent frequencies.

   The values of normal load and short-circuit currents which should be taken into account in this connection are still a matter for discussion. There is, however, a tendency to use, as a basis, the actual load encountered in practice.

   The soil resistivity factor which plays an important part in the sphere of telecommunications, is still illdefined and little known, and continues to be the subject of numerous studies. Several parameters have the effect of modifying the depth of current penetration, which may falsify the results obtained from the various measuring methods in use.

   So far, only few administrations have carried out systematic measurements in this sphere, though it would be highly desirable to proceed with such measurements. It would, moreover, be very fortunate if the measurements could be carried out in accordance with standardized methods, and with the collaboration of the organisations or Administrations interested in the question.

4. The compensating factors able to influence the coupling effects are apt to vary greatly.

   In several instances of A.C. electrification, with or without return conductors, the use of booster transformers represents an additional compensating factor as it reduces the flow of current in the soil.

   With D.C. electrifications, certain Administrations limit the number of connections between the supporting structures of the catenary and the rail in order to reduce the leakage of traction current to the soil. Discharge gaps, which would represent an effective means of reducing the leakage currents, are not often used as they are rather expensive.

5. The question of screening effects is extremely complex. These effects are difficult to measure and, because of the diversity of the relevant factors as between one network and another, it is difficult to interpret the results of the practical tests which can be carried out in this respect. On A.C. electrified lines, however, the question of determining the currents in the conductors (modulus and phase angle) must be faced.

   Some Administrations have carried out, or are now carrying out, measurements in this sphere. So far, however, the results obtained are few in number, and hardly conclusive.

6. Among the precautions taken with a view to limiting the interference phenomena in groups of overhead telecommunication lines running along electrified railway tracks, the following measures can be named: elimination of earth returns; placing the overhead lines at the greatest practicable distance from the tracks (though this factor does not exert a preponderant influence), and mainly, the transposition of the conductors.

   It is important to arrange the lines in accordance with a carefully studied transposition scheme, designed to reduce the transposition intervals. But even with perfectly regularly spaced transpositions, various factors which are unavoidable with the operation of overhead lines are liable to introduce unbalance conditions which are, moreover, apt to vary.

   It would be desirable to carry out supplementary research and studies on the subject of the sensitivity coefficients and their variations.

7. For the installation of telecommunication and signalling cables along electrified lines, buried cables are generally preferred. Some Administrations, however, prefer cable conduits which ensure a better mechanical protection of the cables and which, moreover, contribute to the corrosion protection of the cables in the case of D.C. traction.

   The types of cables in use are generally provided with metallic armouring. They comprise a lead sheath and, fairly often in the case of A.C. electrifications, an armouring of steel tape or wire. Most of the Administrations do not attach particular importance to the use of high permeability armouring.

   The insulation of the conductors is generally of the dry paper type for telephone circuits, and of the impregnated paper type for signalling circuits.

   The use of aluminium sheathing is recommended by several Administrations. In many cases, too, external sheathing or coatings of insulating materials are provided as a precaution against corrosion.

   Little use is made, so far, of cables without metal reinforcement where the conductors are insulated with plastics such as polythene or polyvinyl chloride, or with natural rubber, and where the sheath consists of polyvinyl chloride or synthetic rubber.

Except in the case of D.C. electrifications, the interruption of the continuity of the metallic armouring is not a widespread practice. In some cases where this is done, the joints are not bridged by capacitances.

With D.C. traction, the sheathings and armourings of the cables are not generally earthed except sometimes at one point. But this practice is more widespread in the case of A.C. traction.

The volume of information provided on the subject of the screening factor of metallic sheathing is rather small. The factor varies with the frequency and with the saturation condition of the metal armouring.

8. The precautions taken against longitudinal induced voltages consist in ascertaining that these voltages, even in the most unfavourable circumstances, remain far below the breakdown test voltage between conductors. The usual interruption of the circuits at the amplifiers may be sufficient to reduce these voltages. Intermediate sectionalisation by means of 1/1 isolating transformers may however, become necessary. This measure gives rise to the problem of verifying the insulation of the conductors which can be done by different methods.

The protection devices in use are of conventional types : fuses, thermal coils, overvoltage protection devices, lightning arresters. The use of rectifiers as a precaution against acoustic shocks is also reported.

9. As a result of the precautions taken, the disturbances experienced are very small. In some cases, they are confined to occasional breakdowns or unbalance conditions.

Little information has been provided on the subject of the noise voltages observed, but these values always seem to be very small.

10. The value of the potential against earth has not generally been reported, but it does not, in any case, exceed 120 V under normal working conditions.

For safety reasons, the staff are often required to adhere to certain rules when carrying out work on the circuits; these rules take into account the measures taken to reduce the voltages to which the staff are liable to be exposed. Special precautions may become necessary if the cables are placed close to a live catenary. Normally, no special precautions are taken in the case of signalling circuits, because of the short length of the latter.

11. The most effective way of guarding against the danger of electrolytic corrosion (which need only be taken into account in the case of D.C. electrifications) is to reduce the electric resistance of the track as much as possible, and to insulate the rails as effectively as possible from the soil. It is, however, necessary to ensure that the rail-earth potential does not become dangerous to staff.

Apart from resorting to cable conduits, special sheathing, special tape wrapping, or interruptions in the electric continuity of the armouring (passive protection), the cables are sometimes also protected by polarized drainage or tapping (active protection).

12. The problems associated with the working of track circuits differ for D.C. and A.C. electrifications, respectively.

The questions of unbalance phenomena in track circuits in two lines of insulated rails, and of the induction effects to be expected between a track circuit and the contact wires or rails of the adjacent track, would seem to merit closer studies than has been the case so far.

The connection schemes are so designed as to ensure safety even under abnormal conditions prevailing in the traction network.

The inductive connections used in the track circuits are so designed that an unbalance not exceeding a certain value

(which, incidentally, varies as between one Administration and another) between the two windings does not disturb the working of these circuits. All the receiver apparatus used in the track circuits must be designed to work with particularly high selectivity.

It is considered that the systems in use do not call for special precautions as regards transient phenomena.

Overvoltage protection, where this is deemed necessary, is obtained either by means of spark gaps or discharge gaps or by means of a judicious adaptation of the equipment (transformers becoming saturated when the currents become too high).

13. *With D.C. electrification,* the following types of track circuits are used :
   — A.C. feed at industrial frequency (42, 50, 60 and 83.3 c/s), using induction relays with two de-phased elements or, sometimes, rectifier relays;
   — A.C. feed at frequencies of the order of 1 000 to 20 000 c/s or with high tension impulses, obtained by means of electronic apparatus, using appropriate D.C. relays;
   — track circuits with coded currents, using coding and decoding relays;
   — sometimes, for very short track circuits, D.C. feed.

   Where single-rail track circuits are used, a length limitation must be accepted. Certain Administrations take further precautions in order to protect the equipment and to ensure the proper working of the installations. Other Administrations regard these precautions as unnecessary as they do not enhance safety.
   With two-element induction relays, the effects of the harmonics of the rectified current need not be feared. With rectifier relays, the length of the track circuits must be limited.
   The use of protective devices (fuses or discharge gaps) varies greatly as between one Administration and another.

14. *With A.C. electrifications,* the following types of track circuits are used :
   — D.C. feed, using D.C. relays with special characteristics (short-circuit rings or windings), series-connected with inductive elements offering a high impedance to the traction current;
   — A.C. feed at 42.75 and 100 c/s for 16.2/3 c/s traction, and at 83.3 c/s for 50 c/s traction, using induction relays with two de-phased elements with two or three positions.
   — A.C. feed at frequencies of the order of 1 000 to 20 000 c/s or with high-tension impulses obtained by means of electronic apparatus, using appropriate D.C. relays;
   — track circuits with coded currents, using coding and decoding relays.

   The feed voltage frequencies are so chosen as to keep away from the frequency of the traction currents and its most important harmonics.

15. The measures taken to avoid disturbances liable to arise from interference of the traction current with signalling circuits other than track circuits consist in a judicious choice of the type and voltage of the feed, and of the type of equipment.

   Two-wire circuits are preferred, without earth connection, and generally with bipolar break.

   In the case of A.C. electrifications, it is necessary to take into account possible longitudinal voltages, with a view to the safety of the staff.

16. As far as the telecommunication lines are concerned, one tries to keep the psophometric electromotive force within the limits recommended by C.C.I.T.T.

   The long-distance telephone circuits of the general network are, in many cases, worked with carrier current equipment with a small number of channels, e.g. of the « 3 + 3 » or « 12 + 12 » types which are less sensitive to induction.
   Generally, the C.C.I.T.T. recommendations are adhered to.

SECTION III : Working.

[656. 225]

QUESTION 3.

Transport on railway wagons of road-lorries and trailers loaded with goods.

Questions arising from this mode of transport :

— **The role of the road-hauliers;**
— **Tariffs to be applied;**
— **Characteristics of the railway rolling stock to be employed;**
— **Installations for loading and unloading;**
— **Use of single wagons, or of sets of wagons, or of complete trains for this kind of transport.**

Results already obtained and possibilities of extending this mode of transport.

SPECIAL REPORT,

by L. Lohier,

Ingénieur en Chef,
Chef adjoint de la Direction Commerciale de la Société Nationale des Chemins de fer Français.

Question 3 was the subject of two reports :

— a report by Dr. G. Schrader, Bundesbahnoberrat in der Hauptverwaltung der Deutschen Bundesbahn, Frankfurt (Main), Germany, for the following countries :

America (North and South), Australia, Burma, Ceylon, Egypt, Federal Republic of Germany, Ghana, India, Indonesia, Irak, Iran, Republic of Ireland, Japan, Malaya, Netherlands, New Zealand, Norway, Pakistan, Philippines, South Africa, Sudan, Sweden, United Kingdom of Great Britain and Northern Ireland and dependent overseas territories, Union of Soviet Socialist Republics. (See *Bulletin* for January 1960, p. 1);

— a report by L. Lohier, Ingénieur en Chef, Chef adjoint de la Direction Commerciale de la Société Nationale des Chemins de fer Français, for :

Austria, Belgium and Belgian Congo, Bulgaria, Cambodia, Czechoslovakia, Denmark, Ethiopia, Finland, France and French Union, Greece, Hungary, Italy, Lebanon, Luxemburg, Poland, Portugal and overseas territories, Rumania, Siam, Spain, Switzerland, Syria, Turkey, Viet-Nam, and Yugoslavia. (See *Bulletin* for February 1960, p. 105.)

Replies were received from 24 of the 109 Railway Administrations to whom the questionnaire drawn up by these two Reporters was sent.

We wish to thank them most sincerely for their contribution to the study of the question covered by the present report.

* * *

GENERAL.

The transport of road vehicles on wagons may be the result of two different preoccupations on the part of the railways :

— to improve the service offered and reduce the cost of transport whilst assuring « door to door » services without disturbing the load; the problem then only arises in those cases where such « door to door » transport cannot be assured by means of private sidings, or if the effects of dividing the load at the station cannot be reduced by the use of special types of wagons or modern handling methods;

— to fight road competition in the case of long distance transport by creating a formula for *effective co-ordination* assuring to each method of transport the share to which its special qualities entitles it.

The latter preoccupation was the one which lies essentially behind the studies and realisations of the Administrations, who have dealt with this problem.

Such a situation can be explained, at least in part, by the relative evolution of the transports carried by rail and by road, an evolution which in every country has taken place to the detriment of the railway.

The value for the railway of a formula for transporting road vehicles on wagons is in particular a function of the possibilities which exist for the Railway Administrations in the field of road transport.

If the railway is allowed to run long distance road services, it can operate such services itself in cases where there is competition. However, this in itself does not diminish the existing road transport potential, and it may still be an advantage to tie down a part of this potential by transporting the corresponding road vehicles.

But it would appear that most of the Railway Administrations who replied are not allowed to organise road services apart from those services which are complementary to the railway. Combined transport, the subject of the present report, then becomes of particular importance by associating the railway with the running of road services by transferring to the railway an important part of the end to end journey.

In any case, the transport of road vehicles on wagons is only of interest to the railway to the extent that it does not mean that any regular traffic that has been carried by rail is now being switched over to this form of combined transport. On the other hand, it enables the railway to avoid losing traffic carried to date by rail, when the technical conditions no longer satisfy the client and he has decided to go over to road transport.

An essential factor for the successful transport of road vehicles on wagons lies in the choice of a formula that takes into account the existing relations between the two methods of transport and the habits and temperament of the professional road hauliers.

The introduction of such a combined method of transport has the greater chance of success the more it is supported by the whole of the road haulage firms, or if this is not the case, by at least a part of them. If must therefore take into account in particular :

— the possibilities of binding users more or less closely to the railway;

— the possible insistence of these users on retaining their commercial entity, i.e. keeping direct contact with their clients, so that the railway only fills the role of a rail haulage service.

The position of the Administrations as regards carrying private road vehicles on

wagons (transport on one's own behalf) covers a much wider range, from a pure and simple refusal to accept such traffic without restriction or only accepting it under certain conditions.

In so far as it leads, under satisfactory conditions as regards profitability, to a transfer to the railway, over a great part of the journey, of traffic so far carried by road, carrying road vehicles on wagons meets the general interest :

— by assuring to the user the benefits of both road transport (door to door transport without breaking the load) and rail transport (regularity, security, rapidity of transport, lower cost due to the replacing of many motor units by a single one);

— by improving the user and therefore the profitability of the railway system, the retention of which in any event is necessary in most cases;

— by easing the position for road traffic by making the roads less congested and therefore safer;

— by enabling as a consequence the governments to make a more rational use of the funds available for improving the roads;

— and finally by leading to a better user of the power by such an association of the two methods of transport.

Finally, at a time when international traffic is constantly increasing, and the economic barriers between different countries are fast disappearing, it has seemed necessary to certain Railway Administrations not to limit the transport of road vehicles on wagons to the *national territory alone.*

Other Administrations, who have not begun or continued such studies of combined transport for their own internal needs because of the geographical configuration of their country, consider that such combined traffic in the case of international services may be of interest in view of the long distances involved.

There is therefore a need for technical standardisation of the international plane.

* * *

TECHNICAL QUESTIONS.

On the *technical plane,* the problem lies in reconciling railway requirements as regards loading gauge and maximum weight per axle with the characteristics of road vehicles which depend on the regulations concerning road traffic.

It should be noted first of all that if the Railway Administrations in each Continent have managed to achieve a certain standardisation of their carrying stock, this is not the case as regards the loading gauges used on the different Railways which differ very considerably. Moreover, the characteristics imposed by the various road traffic regulations differ from country to country and sometimes even within a country. This is one of the reasons for the diversity of the solutions proposed.

These solutions can be classified, as far as their principles are concerned, into five categories :

First category : Ordinary wagon, slightly adapted. Ordinary road vehicle.

This solution is only possible when the railway loading gauge is a high one, especially at the corners. This is the case in Canada and the United States where ordinary flat wagons, fitted with the necessary locking devices, can be used to carry ordinary semi-trailers.

Second category : Ordinary wagon, possibly slighty adapted. Special road vehicle.

This is the formula used by certain Administrations whose loading gauge does not allow the first category to be used.

First sub-category : The road vehicle is of standard type apart from its adaptation for transport on a wagon :

— special trailer (Austrian Railways);

— U.F.R. semi-trailers (S.N.C.F. and Abidjan-Niger Railway).

Second sub-category : The road vehicle body can be lifted off its chassis, and only the former is carried on the wagon. On this principle were designed :

— the « Burger » and « Von Lienen » (Deutsche Bundesbahn) semi-trailers;

— the Kögel-Wortmann system (Deutsche Bundesbahn);

— the Feraut-Marini (F.S.) system;

— the Mo-Pac system (U.S.A. and Canada).

Third category : Special wagon. Ordinary road vehicle, possibly slightly adapted.

The wagon is specially designed to carry ordinary road vehicles, possibly slightly adapted for this purpose. This is the case with :

— low-loader wagon (Deutsche Bundesbahn);

— SEGI low-loader wagon (S.N.C.F.);

— Clejan system (U.S.A.);

— « Kangaroo » semi-trailers (S.N.C.F.);

— F.S. semi-trailer (Italian State Railways).

Fourth category : Special wagon. Special road vehicle.

Either the body of the road vehicle can be taken off its chassis and only the former carried on a special wagon, as is the case with :

— the Flexi-Van system (U.S.A.),

or simply be adapted for transport on a special type of wagon :

— tank type semi-trailer (British Railways).

Fifth category : Mixed rail-road vehicle.

Such vehicles can run both on the road and on the railway :

— « Uerdingen » system (Deutsche Bundesbahn);

— « Schöttler-Schnieder-W.M.D. » system (Deutsche Bundesbahn);

— « Railvan » system (British Railways and U.S.A.).

Stock having a useful load of 5 t or less (« Arosa » containers of the Swiss Federal Railways and « mobile container trailers of the South African Railways), which come under the category of containers, have been left out on purpose.

From the *purely technical point of view*, the value of each of these methods depends upon :

A) the capital investment (railway and road stock, installations at the terminal stations);

B) the total cost of the door to door transport, which includes :

a) the cost of the railway transport : this may be characterised by the ratios :

$$U_1 = \frac{\text{useful load capacity}}{\text{wagon tare} + \text{tare of road vehicle carried}}$$

$$U_2 = \frac{\text{available loading space}}{\text{wagon tare} + \text{tare of road vehicle carried}}$$

b) the cost of transhipment at the stations where the railway and road make contact with each other;

c) the cost of the terminal road run.

C) the value of utilisation by the user which can be characterised by the relations :

$$V_1 = \frac{\text{useful load available}}{\text{tare of the road vehicle running on the road}}$$

and

$$V_2 = \frac{\text{useful loading space}}{\text{tare of the road vehicle running on the road}}$$

D) the rapidity with which the change-over from rail to road and vice versa is effected and the case and efficiency of the locking devices used.

The table on the following page sums up certain of these data for each method.

In making its choice, the railway takes the following considerations into account:

1) if the railway is responsible for financing and working from one end to the other both railway and road stock and the station installations, it is, on the one hand, considerations of the amount invested and the total costs, and, on the other the needs of clients which form the essential criteria for making the choice of the solution:

2) if the railway merely transports by rail road vehicles which do not belong to it, two main considerations will guide its choice towards one or other of the possible solutions:

— to obtain the lowest cost price for the railway transport and limit the capital investment required; it is the method giving the best useful load offered per ton of tare of the stock (value U_1), which will satisfy the former condition. The second will be met by the choice of a wagon which costs as little as possible (the ordinary wagon representing the optimum) and a method of transhipment at stations involving the minimum of specialised installations;

— to offer the user, whether carrying out transport for a third party or on his own behalf, a vehicle which will meet all his requirements: this will be, always in the case of the professional haulier and often in the case of the private haulier, that road vehicle which has characteristics as similar as possible to those of ordinary road vehicles (for operating reasons) and the minimum of specialisation (because of the capital investment and costs). The adoption of a very special type of road vehicle, although it has the advantage of ensuring that the user will remain faithful to the railway, also obliges him to purchase a more costly vehicle with higher prices, which he may often refuse to do. The best solution for the user is therefore that of an ordinary or very slightly specialised vehicle, which will give him the best values of V_1 and V_2. As the railway is looking for the best value of U_1 as far as it is concerned, the ordinary or slightly adapted semi-trailer will definitely seem to be the best solution.

The application of such a conclusion does not give rise to any problem in the U.S.A. and Canada, where in practice only semi-trailers are used for long distance transport.

It is facilitated in many countries by the tendency noted amongst road hauliers to favour articulated vehicles which makes it possible to uncouple the tractor from the semi-trailer, and thus obtain better user of the motor unit.

However, this is still only a tendency; the constitution of the existing stock of road vehicles and the predominance of lorries over articulated vehicles has led certain Administrations to adopt, at least for the time being till the owners of the vehicles have re-equipped themselves with articulated units, a method which will allow of the transport of lorries, in spite of the great increase in the tare which thereby results.

In view of the restrictions imposed by the railway loading gauge, methods which include automatic centering of the road

Method	Road vehicle	Wagon (1)	Terminal installations	For the railway		For the client (3)	
				U_1 (2)	U_2 (2)	V_1	V_2
I — U.S.A. ordinary semi-trailers	—	ordinary adapted	—	—	—	—	—
II — Ö.B.B. trailer (2 per wagon)	special type	ordinary	—	0.535	1.78	1.59	5.2
U.F.R. semi-trailer vans (S.N.C.F.)	special type	*ordinary adapted*	special	1.25	2.87	3.51	8.05
« Von Lienen » semi-trailer (D.B.)	special type	ordinary	—	0.96 (4)	2.58	2.15	5.8
Kögel-Wortmann system (D.B.)	special type	*ordinary adapted*	—	0.88	2.92	1.53	5.1
Feraut-Marini system (F.S.)	special type	*ordinary adapted*	special	—	—	—	—
Mo-Pac system (Canada, U.S.A.)	special type	ordinary adapted	special	—	—	—	—
III — Low-loader wagon (D.B.)	—	special type	special	—	—	—	—
Low-loader wagon (S.N.C.F.)	—	special type	special	0.56	—	1.36	—
« Kangaroo » semi-trailer van 2-wheeler (S.N.C.F.)	slightly adapted	*special type*	special	1.22	3.35	3.54	9.75
F.S. semi-trailer	—	*special type*	special	—	—	—	—
Clejan (U.S.A.) semi-trailer	slightly adapted	*special type*	special	—	—	—	—
IV — Flexi-Van system (U.S.A.)	special type	*special type*	—	—	—	—	—
Tanker semi-trailer (B.R.)	special type	*special type*	—	—	—	—	—
V — « Uerdingen » system (D.B.)	special type	*special type*	special	1.72	4.2	1.72	4.2
« Schöttler » system	special type	*special type*	special	1.19	2.73	2.22	5.1
« Railvan » system	special type	*special type*	special	2.2 (5)	—	2.2	—
U.I.C. standardised covered wagon	—	—	—	2.0	—	—	—

(1) When the method used ensures the automatic centering of the road vehicle on the longitudinal axis of the wagon, the corresponding mention is printed in italics.
(2) In the case of ordinary flat wagons, a tare of 12.5 t per wagon has been used.
(3) In the case of semi-trailer, the weight of the tractor has not been included in calculating V_1 and V_2.
(4) 1.09 when loaded on a Rmm 33 wagon with a tare of 10.3 t.
(5) This coefficient does not take into account the reduction in the load per axle due to the reduced diameter of the wheels when running on rail.

vehicle on the wagon are those which allow of the maximum useful space being offered to the user.

Moreover, when the road vehicle carried is a semi-trailer the body of which cannot be taken off its wheels, it can be loaded onto the wagon :

— either from a side loading platform : which presupposes that such platforms are already in existence, as it is costly to build them and involves problems as regards space available in the stations;

— or, when there are no side loading platforms, from the end of the wagon from a platform at the end or from a mobile ramp. The trailer has to be backed up in this case so that the tractor can afterwards be removed; this is a long and delicate operation when they are being loaded onto a rake of wagons. The adoption of some system of guiding facilitates and greatly speeds up this operation as well as ensures automatic centering as mentioned above.

Finally, the experience of certain countries shows that it is harmful for ordinary semi-trailers to rest upon their end supports whilst being carried by rail. In effect, these end supports are built to stand static compression stresses and are likely to be damaged by the oblique stresses set up whilst the wagon is running (shocks, centrifugal force...). It has therefore been noted that there is a tendency when ordinary semi-trailers are used to equip the wagons in such a way that the semi-trailers are held by their road coupling pins.

The *transport of road vehicles in international service* on the technical plane, apart from the choice of method properly speaking, gives rise to problems :

a) the adoption of a common railway loading gauge which will be the most restrictive one of the countries concerned;

b) the adoption of characteristics for the road vehicles which respect the regulations in force in the country where the terminal road journeys will take place; this will be the most restrictive regulations in the countries concerned;

c) in the case of semi-trailers, standardisation of the couplings between tractor and semi-trailer, the brakes and the electrical equipment.

Although in the case of point *a*), the U.I.C. has successfully obtained the adoption of an international loading guage which makes it possible, in Europe, for wagons to carry out international runs, the road standards still differ considerably from country to country.

* * *

GENERAL ORGANISATION.

Professional road hauliers (carrying out transport on behalf of a third party) are in general subject to regulations requiring them to obtain some form of licence. Private transport is most often exempt from this.

There are two formulae for carrying road vehicles before us :

1) the railway carries out the whole transport from door to door. This formula has the advantage of leaving the railway completely free to organise such transport by itself, making all arrangements with the consignor. If it does not give rise to any particular problems in the case of private transport which can easily be dealt with in this way, on the contrary, in the case of transport on behalf of a third party, it has the drawback of leaving the whole burden of operating the combined technique upon the railway without any guarantee as to the utilisation of the road potential; the latter will either be kept in the services operated by the railway, which will lead inevitably to cut prices, or will be transferred to other services not operated by the

railway in which it will increase the competition.

2) the railway may merely assure the rail transport of vehicles belonging to public or private transport undertakings. The value of this formula in the case of public hauliers is that, in return for the advantages they obtain from the combined transport, they bring to the railway their traffic hitherto carried by road. Therefore, to the extent that professional road transport is subject to official control as to its extent, the object aimed at by the railway to recover competitive traffic which went by road is achieved.

The transport of road vehicles on wagons because it is only of value in the case of vehicles of average or heavy tonnage is only concerned with full loads.

The carrying by wagon of road vehicles belonging to public transport undertakings, if it pays, is always of advantage to the railway, as, for the reasons given above, it enables it to recover traffic which it was losing.

Private transport is a problem of another kind, as it is often difficult to be sure that it is not merely a question of traffic now being carried by wagon being transferred to the combined technique; especially as certain users may be tempted to allocate for the combined transport very old and almost worn out vehicles, keeping their new vehicles for the road. Great prudence is therefore needed in accepting private vehicles; only some Administrations carry them.

* * *

WORKING.

When the railway itself organises door to door services, it can carry out the terminal transport by its own lorry services.

When they carry vehicles belonging to public transport undertakings, many Administrations prefer, for psychological reasons, to let these undertakings remain in contact with their clients, and consequently operate the terminal transport.

When the vehicle carried is a semi-trailer, certain Administrations have found it of value, in order to obtain a better user of the tractors and standardisation of the traction costs, to encourage the road transport undertakings to organise the terminal haulage, either by forming special companies for this purpose in which they hold shares, or by leaving it to them to set up one or more tractor pools for each station with such a service.

The importance of the terminal transport varies from country to country. It depends upon the existing road regulations and the profitability of running the road vehicle in question on the road.

The best solution for the railway as regards the rail run is the complete train. This makes it possible to obtain the minimum traction costs and optimum profits from the terminal installations; the latter result is of particular importance when the method selected involves costly terminal installations. But complete trains presuppose the existence of sufficient traffic on the services in question; the number of services will therefore be reduced. Very few Administrations practise this formula.

Sending forward by single wagon has the advantage of covering the whole country by multiplying the places served, and consequently reducing terminal road runs and increasing the rail runs to a similar extent. It is only practicable to the extent that the terminal installations are sufficiently cheap to be profitable with the reduced amount of traffic.

The method of combined transport used and the method by which it is sent by rail therefore have a reciprocal influence. In any case, it is apparent that the time taken for the rail transport must be the same or better than by road, otherwise the public transport undertaking with a

poorer user of its vehicles and consequently a reduced transport potential, will not see any advantage in using combined transport.

The wagons and special stock apart from the road vehicles belong, according to the Administrations, either to the railway or to private companies; the latter solution has the advantage, on the one hand, of bringing in private capital for the combined technique and consequently relieving the railway budget, and on the other hand, of interesting private interests in the success of the undertakings.

* * *

TARIFFS.

The question has been settled in very different ways in the various countries. A distinction must be made between those cases where the railway works the traffic from one end to the other on its own, and that in which professional road transport undertakings are also concerned in the working.

In the first case, it is a question of the charge for the whole door to door service; according to existing conditions, either the obligatory road tariffs (D.B.) or competitive rail-road tariffs (U.S.A.-Plan II), or the sum of the railway tariff applicable to the goods and a haulage charge (South Africa) is applied.

In the second case, the railway only assures the rail transport of a vehicle belonging to a public transport undertaking; it charges the latter a price for the rail traction, the client paying the public transport undertaking the cost of the door to door transport. The railway charge includes :

— either a set charge for each semi-trailer (U.S.A.-Plan I);

— or a charge for each loaded wagon as a function of the distance but not of the load (D.B.);

— or a rate depending upon the gross tonnage carried and the distance (S.N.C.F.);

— or the amount of the tariffs applicable to the goods carried calculated on the gross tonnage of the loaded vehicle (C.F.F.) or on the weight of the goods loaded with a fixed sum per semi-trailer and per kilometer (Abidjan-Niger Railway).

The differences in the tariffs depend upon the special conditions obtaining in each country, in particular : the amount of competition, the greater or lesser advantage to be obtained by carrying road vehicles on wagons, the existence of obligatory road tariffs.

The level of the tariffs often depends on the cost to the railway and the cost to the road haulier, so that it is higher on the former for the rail run, and at least equal to the second, for the door to door service, taking the terminal transport into account.

* * *

RESULTS.

The comparative results for 1958 are given in the table on the following page.

The evolution of the transport of road vehicles on railway wagons in the U.S.A. and France can be seen from the following results (see p. 530) :

It appears that only the German Federal Republic, France and the U.S.A. and Canada have got past the trial stage of prototypes into commercial operating.

* * *

We have endeavoured to sum up in the present report the essential data concerning the transport of road vehicles on wagons according to the replies received. This has led us in collaboration with Dr. Schrader to submit the following summaries as a basis for the discussions at the Brussels Meeting.

	U.S.A. and Canada	*German Federal Republic*	*France* (1)
Tonnage of goods carried	—	42 542 t	750 000 t
Average distance of rail transport .	400 km (between 240 and 1 600 km)	400 km	500 to 570 km
Average distance of terminal road transport	maximum 48 km in the case of vehicles owned by the railway	20 to 25 km	about 20 km
Number of stations equipped for rail-road contact	—	19	160
Number of road vehicles carried . .	—	3 743	203 952
Number of wagons	276 767	—	—
Number of semi-trailers used for the combined technique	—	—	1 909

(1) The results only concern the U.F.R. system, the S.E.G.I. system only having been put into commercial operation during 1959. In 1959, 10 000 t for 535 road vehicles carried were transported on S.E.G.I. wagons.

	1955	*1956*	*1957*	*1958*
U.S.A. : *Number of wagons loaded*	168 150	207 783	249 065	276 767
France : *Number of semi-trailers carried*. . . .	167 000	194 000	218 000	204 000

SUMMARIES.

The advantage of carrying road vehicles loaded with goods by rail.

1. The Administrations in general consider that the transport by rail of road vehicles loaded with goods has undoubted advantages for the railway traffic (at least as regards international traffic in the case of those railways where such transport is not possible internally on account of the short distances involved).

The Administrations operating to this formula or who have made trials of it are generally in favour of extending it.

The essential motives for their interest in this formula are :

a) it is an excellent solution of the door to door problem;

b) the technical co-ordination of rail and road brings back long distance traffic to the railway and relieves congestion on the roads.

Organisation of the service, part to be played by the road transport undertakings.

2. In carrying out such services, two formulae have been used :

   a) service assured from one end to the other by the railway;

   b) service assured by the road transport undertaking, which hands over the vehicle to the railway for the journey by rail.

The first formula has the advantage of giving the railway complete control over the traffic, and assuring direct contact with the clients, with the possibility of encouraging them to the greatest possible extent to make use of the most advantageous method : wagon or the rail-road formula. It is valuable in particular in those countries where the railway is authorised to run road services.

The second formula leaves control of the traffic in the hands of the road transport undertakings for whom the railway merely provides the rail transport. It has the advantage in those countries where public road transport undertakings are licensed on a quota basis, of diverting to the railway part of the road transport potential in the case of transport carried out for a third party which would continue to go by road if the railway would only carry out transport over the whole run; it also attracts private transport which, in the case of the first formula, would not be entrusted to the railway.

The choice between the two formulae is therefore a function of the ruling system governing the railways and the roads in each country, as well as of the possibilities of collaboration between the railway and the road transport undertakings, and the advantage of such collaboration for the railway.

Technical questions.

3. The chief formulae which have been used or tried are :

   a) transporting an ordinary road vehicle on a standard type wagon;

   b) transporting a special type of road vehicle on a standard type wagon;

   c) transporting a standard type of road vehicle on a special type of wagon;

   d) transporting a special type of road vehicle on a special type of wagon;

   e) combined rail-road vehicle.

4. The first formula is obviously the most satisfactory. It is widely used in North America, but is not possible in Europe owing to the dimensions of the railway loading gauge.

5. The fifth formula is attractive, but raises delicate problems owing to the difficulty of reconciling the road and railway techniques and regulations (weight, dimensions). In addition, it would appear that it could only be adopted in cases where the railway itself carries out the transport from end to end.

6. The three other formulae each have their advantages and drawbacks. Various considerations affect the choice to be made between them.

   The loading and unloading of the road vehicle on the wagon must be as rapid as possible, so as to speed up the transport of the goods.

   The amount and cost of the capital invested in the stock tends to avoid specialisation of both road and railway stock as much as possible.

   The cost of the transport leads to endeavour to have as low as possible a dead weight for both road vehicles and wagons, and the greatest possible load and useful volume, taking into account technical exigencies (loading

gauge, weight on rail, weight on road). This generally leads to preference being given to road semi-trailers (in conjunction with automatic centering on the wagon), the use of which is being extended on the roads of Europe, whilst they are almost exclusively used in America for long distance traffic.

7. It is therefore permissible to think that, in those countries where the formula of agreements with the road transport undertakings is adopted (formula *b* of point 2), it is best to adopt a system allowing of the use of a standard type of road semi-trailer which will only require very slight modification. This is the third formula which is adopted in the United States (Clejan), Germany (low-loader wagon) and France (S.E.G.I. low-loader wagons and Kangaroo wagons).

In addition, the use of semi-trailers has the advantage of avoiding transporting the tractor and road driver, who remain at the operating centre.

Loading and unloading installations.

8. The loading and unloading installations depend upon the rail-road system selected.

Such installations must allow of a rapid change-over from rail to road and vice versa, which at the present time is only assured by self-contained transfer systems. In this connection, the use of some system of guiding the semi-trailers when loading them on the wagons considerably facilitates obtaining such a result.

The capital investment must be limited to the essential minimum needed to enable all the stations where it is desirable to load and unload road vehicles to be so equipped.

The use of mobile loading ramps, which can easily be moved about and used with the minimum of alteration to the station would appear a solution to be recommended whenever it is technically possible.

Carrying out the transport (single wagons or complete trains).

9. Sending forward by complete train has great advantages by giving a shorter transport time and lowering the cost for the railway.

This is the method to be recommended whenever the traffic is sufficient; it involves limiting the number of stations where such traffic can be accepted, with the corollary that the terminal road hauls will be increased.

10. Sending forward by single wagon or groups of wagons) meets the case when the traffic is insufficient to form complete trains; it allows a great many stations to be served and limits the terminal road hauls to short distances; the wagons must be sent on by fast goods trains in order to assure that the transport time remains competitive.

Terminal road runs.

11. These services are assured either by the railway or by road hauliers, according to the operating formula adopted. Certain Administrations limit the length of the terminal road runs; such restrictions may also be the result of the road traffic regulations in force in the country in question.

In general, the drivers do not travel with the road semi-trailers carried by rail, so that it is an advantage to provide road transport organisations at the terminal stations. Such organisations can be set up either by the railway or by the road transport undertakings.

Tariffs.

12. When the railway works the traffic from end to end, it charges clients directly a transport rate which may be either a door to door tariff (for example the road tariff if there is one) or the railway rate plus a haulage charge.

13. If the railway is merely providing transport for a road transport undertaking, it has no direct contact with clients and charges the road firm a rate for the railway journey.

    In view of the special features of this traffic, and according to the tariff formula adopted by most of the Administrations, who have experience of this kind of transport, it is recommended to establish the rate independently of the kind of goods and base it on the road costs, taking into account the distance of the transport and the gross weight of the vehicle.

    The tariffs should be profitable to the road transport undertakings who regularly send vehicles over a given journey and thus allow of a traffic programme being established.

Future prospects.

14. In North America, where the very large railway loading gauge facilitates solving the technical problems of rail-road traffic, this kind of traffic is already very extensive.

    The experience of European railways (D.B. and S.N.C.F.), who have already perfected certain solutions to the technical problems raised by a smaller loading gauge, shows that there is also a potential for such traffic in Europe.

15. In any case, we should no expect to get such traffic to the railway in the case of small distances. The minimum distance to be taken into account may be fixed at something like 300 to 400 km.

16. As a result, in the case of regions which are parcelled up politically as they are in western Europe, full expansion of such traffic can only be obtained with formulae for international transport.

17. Owing to the same political divisions, there is a risk of different solutions coming out for the technical problems raised by the small loading gauge. The heterogeneousness of the solutions will act like a brake on any growth of the traffic; to encourage such growth it would be desirable for the railways to co-ordinate their efforts and adopt a common solution, or if this is not possible, at least only a very limited number of technical formulae which will allow of traffic exchanges between all the countries concerned and the use of the same terminal installations.

18. For the rail-road formula to succeed, it is essential for the railway to assure as close a collaboration as possible with the road transport undertakings. Such collaboration may take very varied forms, such as contracts made between the railway and the road transport undertakings, organisations in which the Railway Administrations and the road haulage firms share in working the combined rail-road transport.

19. The fact that the rail-road transport formula is favourable for the general economy justifies on the part of the Governments the setting up of equitable customs and fiscal regulation measures suitable to facilitate its development on the national and international plane.

SECTION IV : General.

[385 .58]

QUESTION 4.

What steps can be taken to develop and maintain co-operation between management and staff to improve productivity?

What scope is there for work study and incentive schemes?

SPECIAL REPORT,

by Edgar J. Larkin, A.M.I.Mech.E., M.I.Loco.E.

Director of Work Study, British Transport Commission, London.

This summary broadly covers the paper written by Mr. E. M. Arys, Inspecteur principal, « Société Nationale des Chemins de fer Belges », and the paper written by the present writer. Both these papers appeared in the March issue of the *Congress Bulletin*. (See respectively p. 203 and p. 229.)

INTRODUCTION.

It is nearly 30 years since the question of productivity was last discussed by the International Railway Congress. Probably the most notable contribution at that time was the special report submitted by Messrs. E Soulez and M. Bloch entitled « Instances of the application in a railway department of the scientific organisation of work. Co-operation of the staff towards increased efficiency and its participation in the profits. »

During the intervening period the « scientific organisation of work » has made enormous strides and continues to develop at an ever-increasing rate in much the same way as one is conscious of great technical progress being made in other spheres, including the technical departments of the various Railway Administrations.

The replies to the questionnaire for this current survey have proved to be extremely informative and are particularly opportune at a time when many Railway Administrations are faced with major problems resulting from an era of full employment and highly competitive forms of alternative transport. We see the private motorist, freight road transport and the aeroplane all increasing at a rapid rate.

The Administrations which replied to the questionnaire — representing the the majority of the railways of the world — make it apparent that there is an increasing awareness of the need to improve productivity. The high labour content of railway expenses and, all too frequently, the low utilisation of equipment, make it imperative for railways to increase their existing levels of productivity. Transport adds nothing to the quality of the product; it only adds to its final cost, and those charged with running the railways must see that all grades, both management and men, are always conscious of this inescapable fact.

It is interesting to put on record those Administrations which have replied to the questionnaire :

List A.

English Questionnaire.

Association of American Railroads;
British Railways;
Canadian National Railways;
Chemins de fer de l'Etat, Argentine;
Chemins de fer Néerlandais, S. A. (Holland);
Chemins de fer de l'Etat, Norway;
Chemins de fer de l'Etat, Sweden;
Chemins de fer de l'Etat, U.S.S.R.;
Coras Iompair Eireann (Irish Republic);
Deutsche Bundesbahn (West Germany);
East African Railways and Harbours (Kenya);
Egyptian Republic Railways;
Japanese National Railways;
London Transport Executive (United Kingdom);
New South Wales Government Railways (Australia);
Nigerian Railway;
Rhodesia Railways;
South African Railways and Harbours;
The Railway Board, Government Railways, India.

List B.

French Questionnaire.

Chemins de fer du Benguela (Portugal);
Chemins de fer de l'Etat Danois (Denmark);
Chemins de fer Emmental-Burgdorf-Thun (Switzerland);
Chemins de fer Fédéraux Suisses (Switzerland);
Chemins de fer de l'Etat Hongrois (Hungary);
Chemins de fer de l'Etat Italien (Italy);
Chemins de fer Yougoslaves (Yugoslavia);
Red Nacional de los Ferrocarriles Españoles (Spain);
Société Nationale des Chemins de fer Belges (Belgium);
Société Nationale des Chemins de fer Français (France).

I. What steps can be taken to develop and maintain co-operation between management and staff to improve productivity ?

We are agreed that overall figures of productivity are not as a rule very helpful. From the replies received we have formed the opinion that improvements in productivity are best reflected by measuring the performance at local level. Areas of activity which might well be the subject of close critical examination to ascertain the effective utilisation with a view to improving the level of productivity, can be said to fall into the following broad classes :

1. Marshalling yards.
2. Stations.
3. Goods and parcels depots.
4. Maintenance work of all types, e.g. permanent way, bridges, buildings, machinery and equipment, signalling apparatus and road vehicles.
5. Building and maintenance of locomotives and rolling stock.
6. Storekeeping with particular reference to the amount of stock carried.
7. Office organisation, covering both clerical and technical work.
8. New projects of all kinds examined at the design and planning stage with a view to reducing the capital cost, and subsequent maintenance costs.

The initial approach should not be to find a better method giving higher productivity, but to examine the need for the job at all.

The majority of normally compiled statistics which attempt to give an indication of the efficiency of the undertaking mean little or nothing if an attempt is made to compare one Administration with another. Each country has so many factors peculiar to itself that direct overall comparisons are meaningless.

Productivity is an all-embracing term and, if the special means by which it is

increased, such as Operational Research, Work Study and Organisation and Methods, and any other special technique which may exist today or may develop in the future, are run in watertight compartments rather than as a co-ordinated whole, the work to be investigated may overlap.

Productivity is not merely using labour to the best advantage. It is equally important that the equipment provided should be utilised to the fullest extent possible; examples given in the papers presented show clearly the waste which can occur.

Technical progress throughout the railways of the world has been considerable and has been accelerated within the past decade. The means for improved productivity have also developed, but there is much that still remains to be done to ensure the highest utilisation.

New methods often require the retraining of staff. It is a mistake to assume that men will automatically be able to carry out the new arrangements. With new methods, whatever form they may take, the men's representatives should be consulted at all levels. The goodwill of the men must be obtained, otherwise the success of any new equipment or new layout can be jeopardised.

The level of pay for each grade must be commensurate with the skill of the job, otherwise continuity of experience, so vital in railway working, will not be available at the level required.

The staff want to see a carefully thought out promotion scheme. They also require guarantees of security, otherwise progress in improving productivity will be retarded. If less staff are required the situation can usually be met by natural wastage and the temporary curtailment of recruitment.

The lack of good working conditions can militate improved productivity, and every reasonable step must be taken to ensure standards which compare favourably with current practice elsewhere.

However much working conditions are improved, the staff may have a tendency to relax their efforts, hence the importance of close personal contact rather than written instructions being given which appear to the staff to emanate from some remote quarter.

Suggestion schemes, with various awards, should be encouraged; they have psychological value. Although the proportion of suggestions adopted, compared with the total number submitted for consideration, may be small, such schemes encourage all levels of staff to put forward their ideas. Constant publicity is necessary.

My co-reporter has mentioned in his paper the possibility of setting up an international railway productivity office. There is no doubt that this is a useful thought; progress can nearly always be facilitated by seeing what others are doing in a particular field and adapting the same principles to one's own problems. It would be of some practical value if such a central authority could arrange for small international teams to visit establishments where a high level of productivity has been achieved following a critical examination. The mere interchange of information would not be effective.

II. What scope is there for Work Study and incentive schemes?

Thirty years ago, when the subject of productivity was last before the Congress, there was no reference to the important part to be played by Work Study in improving the level of productivity. This was because Work Study, as it is understood today, has only been developed to its present high level over the past fifteen years.

Work Study is defined as the critical examination of any work with a view to making the most economical and effective use of men, materials, equipment and buildings.

Improvements do not necessarily have to

be obtained by the installation of new and costly equipment; improvements of some magnitude can often be secured by analysing the process and operations carefully, eliminating unnecessary work and motions, and instituting simple practical work reducing methods. There is just as much scope for Work Study in non-technical departments as there is in technical departments. It applies qually to office work.

Work Study is not a subject in itself; it is a collection of diverse techniques inseparably associated with good human relations. Properly applied, Work Study proves a most powerful aid to management. In its application the staff are kept fully informed of all that is being done by personal contact. Indeed, the staff can make valuable suggestions in the development of any new method and are encouraged to do so.

It is not uncommon for management to react to the suggestion of a Work Study investigation being made much more strongly than the staff under them. Such management take the view that it is a reflection on the way in which they perform their function and they are resistant to changes being introduced. It is a cardinal principle of Work Study that there should be no recrimination. The aim should be to develop a good team spirit in the interests of better service to the customer and improved conditions for the staff.

Work Study and incentive schemes are not synonymous. Work Study is a valuable aid to management and incentive schemes are merely one aspect of *work measurement* which in itself is only part of Work Study. Work Study in railway undertakings is probably 80 % *method study* and, although *work measurement* is complementary to *method study,* it does not necessarily follow that the circumstances require an incentive scheme to be introduced.

If the performance is already high, say not less than 75 on the 0-100 scale, it may not be necessary to introduce an incentive scheme with all that is involved in running it.

The benefits of Work Study, under such earlier titles as Time and Motion Study and Job Analysis, were, for about fifty years, associated with productivity in workshops, especially those engaged in repetitive work of one kind or another. During the last decade substantial developments have taken place in a wide range of industrial activities. So far as the railways are concerned, these include maintenance work of all kinds with which the technical departments of the railways are mainly concerned; also such varied activities as stations, goods depots, marshalling yards and office working. Quite recently Work Study has entered another field, the initial planning and design of different types of projects, on which it has made considerable impact.

Although one can point to excellent results having been achieved which, collectively, cover almost the entire range of activities to be found in a railway undertaking, the replies indicate that there is still much investigating work to be done before it can be said that a high proportion of the total volume of railway operation has been covered.

Productivity indices require to be easily understood by all concerned. The measuring of departmental performance, in accordance with Work Study practice, has a great deal to commend it. Work Study has the great advantage that it requires on-the-spot investigation by close contact with the men actually doing the work.

Work Study defines the approved method for any activity in complete detail and then, by means of the standard minute or standard hour, provides a basis for measuring the output of each operator. These standard units contain a proportion of time for work and a proportion of time for rest according to the nature of the activity. The observed rating or performance of the operator, or operators, is recorded for each separate element of the

activity and the actual time taken during observation is subsequently adjusted to the appropriate time at standard performance.

Staff and local management should always be encouraged to take an interest in the general running of the industry and not merely their own job or departmental activity. The railways must run as a co-ordinated whole and not as a collection of independent units each pursuing its own aim.

There are some Railway Administrations which favour incentive bonus schemes, whilst others do not favour them. There is evidence that some outside industries which have practised incentive schemes over a long period of years, are in process of abolishing them and substituting a higher time-work rate. It is, however, significant that where this step has been taken, the performance, as understood by a trained Work Study man, has been raised to such an extent during the period whilst the incentive bonus scheme has been in operation, that its continuance, with all that it involves in clerical labour, is unnecessary. *Method study* should invariably precede the introduction of an incentive scheme and if, following the *method study*, it is revealed, by *work measurement*, that the performance is high, say 75 or more on the 0-100 rating scale, it may be sound policy not to introduce an incentive scheme.

With incentive schemes the individual system is a more powerful incentive than a group bonus scheme. In introducing incentive bonus schemes, it is important to ascertain to what degree differentials will be affected between one grade and another if some grades do not rank for bonus payments.

The fallacy of paying incentive bonus on a 50/50 basis is fundamentally wrong. To do so puts a premium on inefficient working, because the staff who were least efficient before the scheme was implemented would receive the highest bonus.

To sum up, it can be said, on the evidence submitted in the replies to the questionnaire, that :

III. Summaries.

Part I.

1. It is generally agreed that of the factors contributing to increased productivity, the human factor is the most important.

   Experience has shown that a passive attitude on behalf of the staff can not only retard but even prevent any increase in productivity which is otherwise technically possible.

2. The Administrations endeavour to create an atmosphere of confidence by :
   - — explaining to their staff, the meaning of productivity, the reasons for increasing and the means to achieve it;
   - — minimizing any disagreeable consequences which may arise temporarily from the changes necessary to increased productivity;
   - — having their staff participating in one way or another, in the resulting benefit.

3. There should be consultation at all levels, particularly were changes affecting individuals are contemplated. Central productivity Councils, on which the highest levels of management and the Trades Unions are represented, are invaluable in maintaining a good atmosphere and keeping the Unions informed at an early stage of management's proposals.

   The success of these Councils is enhanced by the setting up of Committees at lower levels.

4. A feeling of security is essential. In general, there should be no dismissals due to increased productivity. Any reduction in the establishment of staff should be met by internal wastage, transfers and the curtailment of recruit-

ment, even though planned progress may be temporarily retarded.

Any agreement should provide for staff to be transferred if this is inevitable. Whenever desirable and possible, a change of job and any necessary re-training should be arranged to avoid transfer to another centre.

5. A valuable contribution to increased productivity is for management to provide and maintain well-conceived training schemes for all grades of staff.

Working conditions must be of a good standard. Staff will always respond better if due regard is paid to their personal welfare.

6. Whilst the provision of general productivity indices is often necessary, it is very advantageous that the productivity of small units such as groups of staff at local level should be clearly expressed.

7. There should be good promotional prospects and the promotion schemes should be clearly defined.

8. Suggestion schemes are invaluable for the submission of new ideas by members of the staff.

9. The exchange of information in regard to productivity should be encouraged. Small teams to visit projects of common interest would be advantageous.

Part II.

10. There is scope for Work Study in every activity associated with a railway undertaking.

11. Work Study provides both a qualitative and a quantitative assessment of the utilisation of equipment and staff in terms which can be universally understood and compared.

12. Work Study investigations should be carried out with the full co-operation of the staff.

13. It is essential that Work Study personnel should be well trained. If investigations are carried out by inexperienced staff, the benefits of Work Study will never be realised. It is clear that many more competent Work Study personnel should be trained if tangible progress is to be made.

14. Providing *work measurement* is efficiently carried out, incentive bonus schemes are a very good means of improving individual performance; they should be substantial if they are to be effective. Individual incentive systems are more commonly used than group incentive systems. Considering future development, it would appear appropriate that incentive schemes should follow a common pattern so far as each group of grades or activity is concerned, because of the uniformity of railway working.

15. Whilst the provision of financial incentives is often necessary, good working conditions and good management in creating the proper spirit of understanding are of equal importance.

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(BRUSSELS, 1960).

[656 .25

QUESTION 1.

The effect of electric traction on signalling and communication circuits, in particular reference to the means of overcoming interference, to provide safety and good communications.

ADDENDUM TO REPORT, (*)

by Prof. Dr. Eng. R. Righi,

Directeur de l'Institut Expérimental des Chemins de fer de l'Etat Italien, Rome.

After our Report was written, we received the reply to the questionnaire from the *Czechoslovak Railways,* which is summarized below.

Power supply.

The substations are fed by the public 100 kV network, where voltage variations of ± 10 % are admitted, with the neutral directly earthed across 100/22 kV transformers.

As the electric traction voltage is 3 kV D.C., the rectifiers are fed by the 22 kV secondary of the transformers referred to above, across transformers with star connected primary and two secondary windings, each of which feeds one set of six single-anode Graetz connected three-phase rectifiers (see diagram). In this way, a 12-phase feed is obtained so that the magnitude of the harmonics of the rectified voltage is reduced and filters can, for the time being, be dispensed with because the undulation factor with 12-phase rectifiers is about one-quarter of that produced by 6-phase rectifiers.

The rectifier power (set of 12 anodes) is 2 400 kW at a voltage of 3.3 kV.

The rectifiers are equipped with control grids. The maximum voltage is 3.6 kV whilst the minimum voltage supplied to the motive power units is 2 100 kV.

The feeders leaving the substations are protected against short-circuits and overloads by means of devices having a cut-out speed of 5 to 20 millisec.

The length of the electrified system is 668 km.

On double-track lines, which are the only ones to be electrified, all the four lines of rails are normally used for the return current.

With the exception of lines where automatic block working is installed, the two lines of rails of the same track are connected at intervals of 300 m, and the two tracks at intervals of 600 m.

The welded electric rail bonds have a resistance not exceeding 2.5 times that of the rail.

The supporting structures of the catenary are earth-connected with the rails (where

(*) See « Congress Bulletin » for May 1960, p. 419.

this is possible). The earth dispersal conductance of a double-track line is estimated at 5 mho/km, with a maximum rail-earth potential of 20 V.

The telecommunication lines are installed in underground cables at a mean distance of 20 m from the nearest rail.

The cables have paper-air insulated cores with lead sheath, steel tape reinforcement without special features, and reinforced passive corrosion protection of the sheath, obtained by means of a layer of PVC or rubber tape windings.

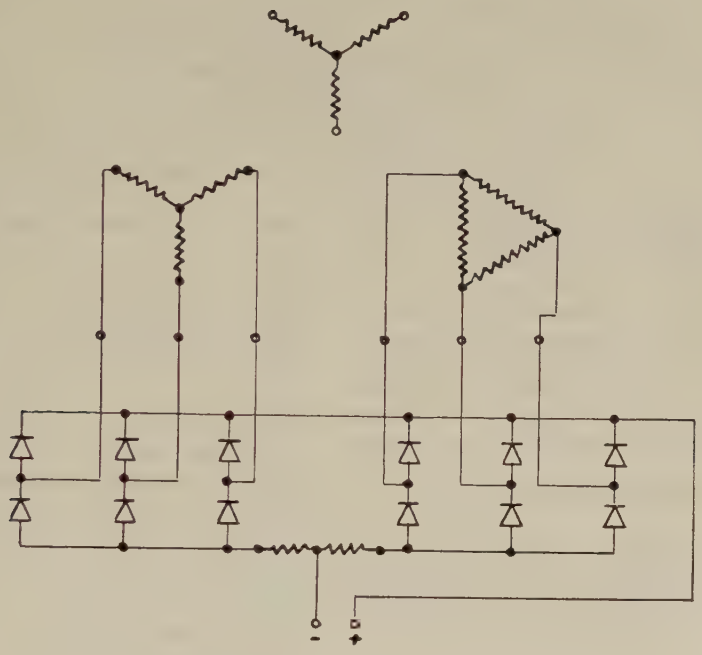
The lead sheaths of the cables are neither interrupted nor earthed.

The telecommunication circuits are protected by 3 A (maximum 5 A) fuses and lightning arresters with a striking voltage of 350 V.

Up to now, the difficulties due to the danger from corrosion caused by stray currents have been confined to minor trouble with telecommunication cables.

The track circuits have a maximum length of 1 500 m and are fed with 50 c/s current coded for the transmission of signal indications to the locomotive. In no case is a D.C. feed provided for track circuits.

For circuits using two lines of rails, induction relays with two elements are used, whilst D.C. relays, fed across a transformer-rectifier, are used for single-rail circuits in stations.



Saturation of the track circuit transformer cores is prevented by the use of special transformers and limit resistances on the feed side and on the relay side.

The inductive connections permit an unbalance of 10 %.

The track circuits are protected by fuses and lightning arresters.

The Czechoslovak Railways are in the process of creating a telecommunications system for all local and long-distance communications. This system will be cabled in accordance with the C.C.I.T.T. recommendations.

[656 .222 .4]

Determining the capacity of railway installations,

by Professor Dr.-Ing. Walter Schmitz.

(*Signal und Draht*, No. 9, September, 1958.)

Conventional methods.

There are numerous methods for determining the capacity of railway lines and railway stations. Whilst the determination of the capacity of the open line is relatively simple (fig. 1), the conventional methods for the determination of the capacity of stations, and notably of zones of points and crossovers, are very complex and are, in the case of major installations, not always very clear. The method becomes even more complicated if it is desired to take into account the length of the different crossover layouts and to achieve an exact determination and clear representation of the successive releases of individual points, obtainable with modern signalling installations.

New methods.

In determining the track capacity, it is possible, without resorting to complete time-distance graphs, to arrive at the same result as with the method shown in figures 1 and 2, by marking on a « blocking time strip » merely those times which are, on each section, relevant to the determination of the capacity.

The following points in time are relevant for this purpose :

1. The moment at which the movement is initiated by the operating official concerned.

2. The moment at which the route setting has been completed and the corresponding signal cleared.

3. The moment at which the section is occupied by the first axle of the train or shunting rake (henceforth called « moving unit » for short) [BE].

4. The moment at which the section is cleared by the last axle of the « moving unit ».

5. The moment at which the route is finally released again.

With modern all-electric signalling of the track diagram type, associated with automatic block signalling, the times 1 and 2 listed above can be merged since the setting up of the route will only take a few seconds. The same applies to times 4 and 5, i.e. the clearing of the section and the release of the route. Thus, in order to determine the total blocking time of a section, it is sufficient to record points 1 and 5 or, in other words, the commencement and termination of the blocking time. It may, on the other hand, be of interest to indicate on the blocking time strip the moment (point 3) at which the section is entered by the first axle of the moving unit. For any given section, e.g. a section of open line, it is therefore easy to show, as in figure 2, a blocking time strip with all the relevant information, viz. points 1, 5 and, possibly, 3, using the length of the section l_n, the distance le_n of point E_n from the beginning of the section N considered, the speed v and the length LBE of the string of wagons or the « moving unit ».

In transferring the points 1, 3 and 5 of the time-distance graph to the blocking time strip shown on the right, it is convenient to inscribe the times relating to the first axle (point 3) on the left-hand side of the occupation line, and the time relating to the last axle (point 5) on the right-hand side of that line. It is thus possible, without creating any confusion, to show the first occupation (on the left) and the clearance (on the right) of a section. This method can be adapted to any blocked section so that it is easy to show the duration of the occupation of this section, caused by the movement of a train (fig. 3).

All that is missing is the indication of the

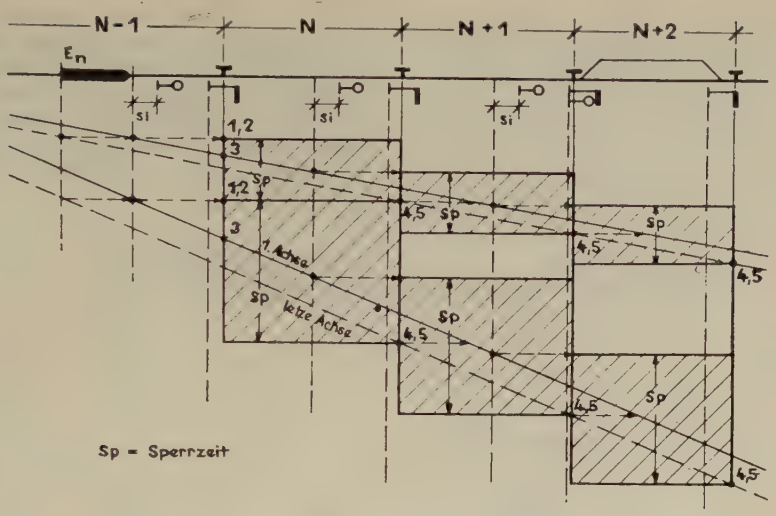


Fig. 1. — Conventional representation of blocking times.

N. B. — 1. Achse = first axle. — Letzte Achse = last axle. — Sp. = blocking time.

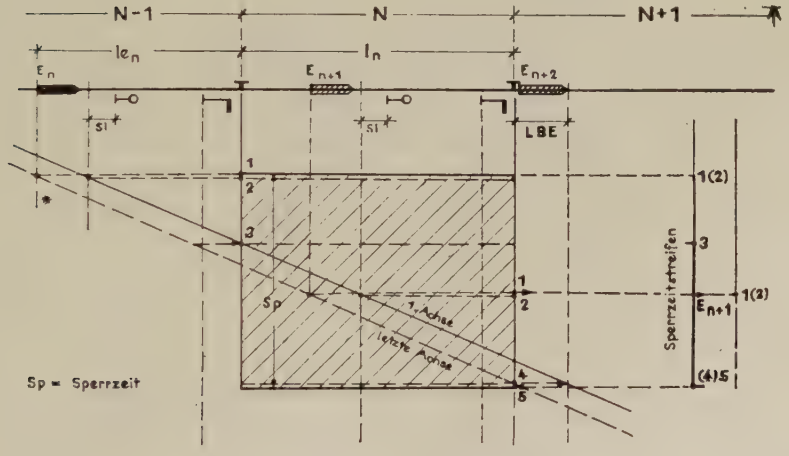


Fig. 2. — Extract from figure 1.

N. B. — 1. Achse = first axle. — Letzte Achse = last axle. — Sp. = blocking time. — Sperrzeitstreifen = blocking time strip.

time relation between the blocking strips N+1 and the blocking time strip N. According to figure 1 the section adjacent to or following upon N + 1 is blocked when the last axle of the train arrives at point E_{n+1} corresponding to that section. This point is generally situated 800 metres (half a mile) ahead of the warning signal of the following section. When the train has reached that point (i.e. when the last axle is at E_{n+1}), the head of the train, i.e. the driver, is at such a distance from the warning signal

that a change from the stop indication to the clear indication can be reliably observed without impairing the normal driving of the train.

All that is necessary is, therefore, to mark in figures 2 and 3 the times at which the last axle passes the points E_{n+1}, E_{n+2}, etc. in order to find the connections with

train is assumed to be slower, one obtains for the different sections certain free periods FZ between two train movements.

Finally, it is also easy to show, without impairing legibility, the time intervals of trains within a proposed timetable by transferring the blocking times to movable cardboard strips.

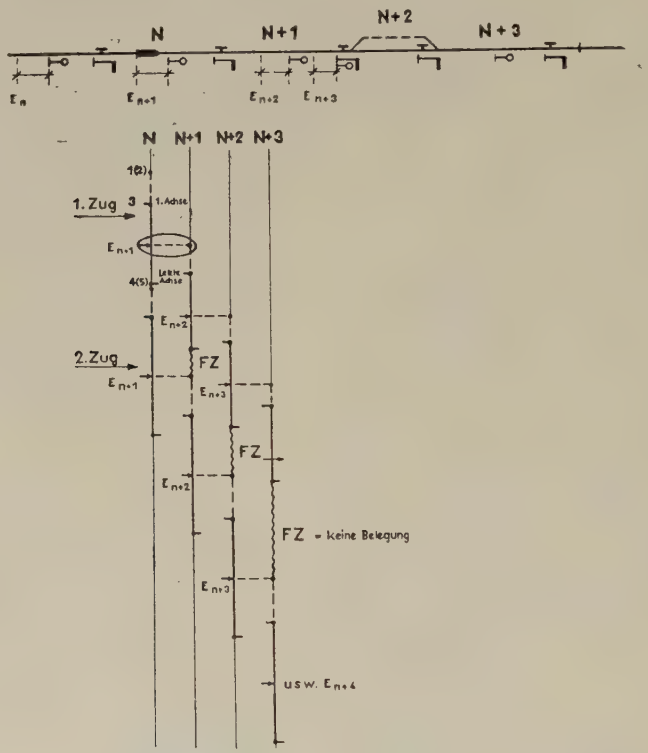


Fig. 3. — Blocking time strip for a section of the open line.

N. B. — 1. Achse = first axle. — Letzte Achse = last axle. — Zug = train. — FZ = free period.

N for the blocking time strips N + 1, N + 2, etc.

This system permits a simple and very clear representation of the times during which the different sections are used by a train movement, in the form of strips representing the blocking times pure and simple (fig. 3).

The passage of a train following can then be recorded in the same way. If the second

The open line track sections considered so far consist exclusively of protective sections, i.e. they are blocked over their whole length, and subsequently released simultaneously over their whole length after the passage of the train.

However, where routes are set up at stations between the home signal and the starter signal, or between the starter signal and the open line, it is necessary to use

certain partial sections of zones of points and crossovers. In this case, although the various points, crossovers and slips as well as the platform roads and corresponding overrun sections are blocked simultaneously, they are, with modern track diagram at that point. In following the running of a train through a station (fig. 4), the blocking conditions for the approach sections A and B are obtained in accordance with the method for open line sections outlined above, as shown in figure 3.

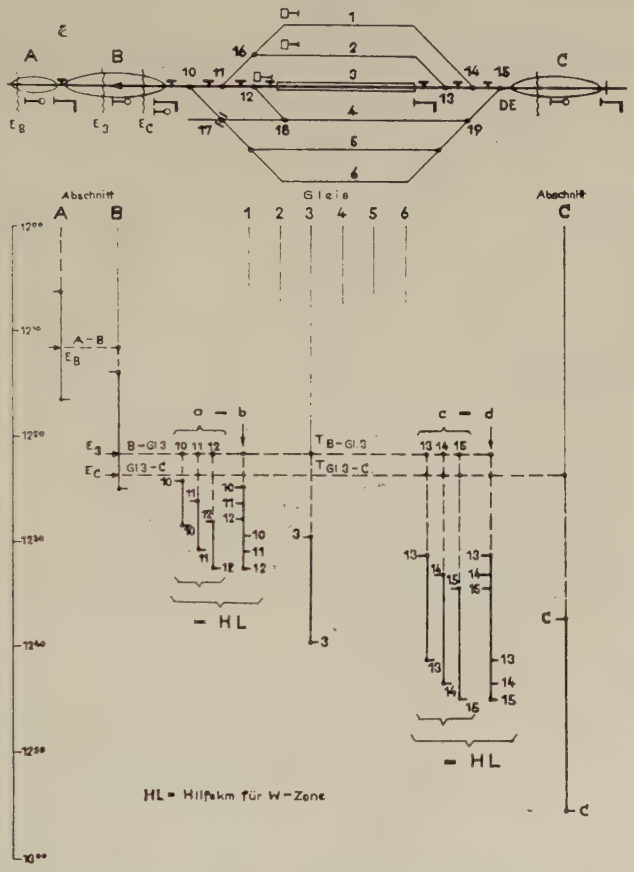


Fig. 4. — Blocking time strip for station routes.

N. B. — HL = fictitious distance for the zone of points and crossovers. — Abschnitt = section. — Gleis = track.

signalling installations, released one by one so as to clear the track as quickly as possible for another movement.

The method must therefore be adapted to show, with equal accuracy, the blocking of the different part-sections, taking into account the length of the train and its speed

For the running of the train from section B to No. 3 Road, points 10, 11, 12 and No. 3 platform road which form part of the same route, must be blocked simultaneously. Moreover, to safeguard against the possibility of the train overrunning the signal, points 13, 14 and 15 must also be blocked.

The time T (B-3) of this blockage, i.e. the blocking time T required for the movement of the train from the open line section B to No. 3 Road, should commence not earlier than at the moment E_3 shown on the blocking time strip B (fig. 4). At that moment, the rear (E) of the train running on section B is at such a distance from the warning signal applicable to the movement to No. 3 Road that the driver is just able reliably to observe a change of the signal indication without being hindered in the normal driving of his train.

If the train runs through the station via No. 3 Road to the open line section C, the blocking time strip for the route 3-C is dealt with in the same way. Its connection in time is found at point E*c* of strip B at the desired distance in space ahead of the starter warning signal.

As far as the protective sections for points 10, 11 and 12 are concerned, one begins by using separate blocking time strips for each of them (solution « a »). The illustration also shows (solution « b ») a blocking time strip common to these points. It is therefore advisable to use, for all the points and crossovers from section B to No. 3 Road, a single blocking time strip provided that it also shows the blocking time of each part-section. The same applies to the overrun section. Here again, the blocking time strips, shown separately in solution « c », have been combined in a common strip in solution « d ».

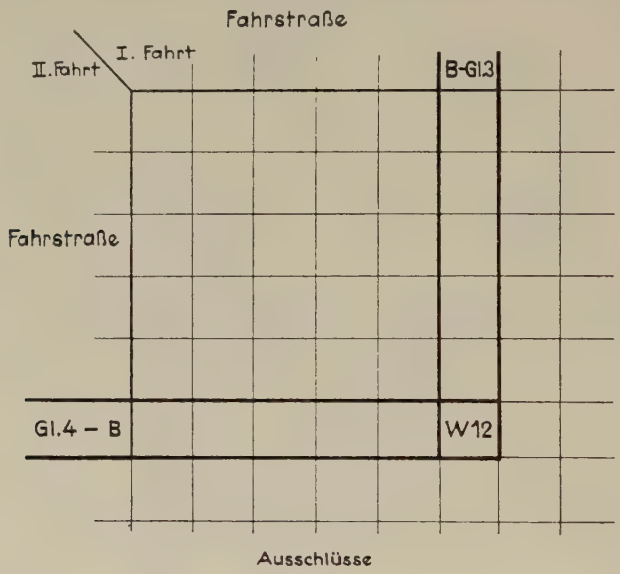


Fig. 5. — Conflicting routes.

N. B. — Fahrt = movement. — Fahrstrasse = route. — Ausschlüsse = incompatibilities. — Gl = track. — W. = point.

The method is thus greatly simplified by the fact that the open line sections as well as the platform roads and the intermediate points can always be covered by a single blocking time strip, irrespective of the number of intermediate sections.

With this method, it is possible clearly to represent the working even of the largest stations, e.g. that of Frankfurt-on-Main where 1 250 train movements and 4 500 shunting movements take place in 24 hours, and to determine the capacity of such installations.

On the assumption of :

24 platform tracks, (here, as in the case of the crossover zone, provision might be made for subdivisions for several trains);

12 approach roads (incoming and outgoing movements) and

8 simultaneous shunting movements (estimate),

the operation of Frankfurt-on-Main station can be represented by 44 blocking time lines.

By using, e.g. 50 blocking time lines spaced at say 1.5 cm, one obtains a blocking strip width of 75 cm. Such a blocking diagram for 24 hours will be between 2 to 3 m long, in keeping with a conventional diagram size.

This diagram may also be used to show, as in the example of the working of a train from A via B to No. 3 Road, and then to C, all the scheduled train and shunting movements implicit in the timetable. It goes without saying that there must be no simultaneous double-blocking of a section on the different simultaneous blocking time strips. Rather, in order to obtain some operating margin, it is desirable to arrange for an appropriate spacing. This desideratum can easily be met as regards the blocking time strips of the approach roads and platform roads i.e. therefore in long sections, which never show more than one blocking mark. With the blocking time strips for the zone of points and crossovers, however, the blockings of several sections are marked on the same strip. Where a section includes points and crossovers, the blocking begins with the setting up of the complete route, whilst the occupation by the first axle and the departure of the last axle as well as the release of parts of the route are merely marked by figures on the left-hand and right-hand sides of the time axis.

By comparing the figures, it is therefore necessary to make sure that there is not, at any time, any multiple blocking on any of the adjacent blocking time strips of the zone of points and crossovers. This also applies to the protecting points, with the corresponding times, which have not yet been mentioned. If there are successive conflicting movements it is therefore always necessary to make sure that the last incompatible section and, if necessary, the protecting points dependent on it are released.

With track diagram type signalling installations, this condition can easily be verified by an experienced signalman as these installations are geographically arranged. In other cases, it is necessary to prepare a table indicating critical sequences of conflicting movements (fig. 5). Here, the protecting point is not indicated; the corresponding part of the route set up previously must be released so that the protecting point incompatible with the new movement can also be released. For example, if (in figs. 4 and 5), the movement from No. 4 Road to B conflicts with the movement from B to No. 3 Road, it is necessary to have No. 12 points released in order to ensure flank protection.

Up to now, we have only dealt with train movements, on the open line as well as over station points and crossovers. The method must be similarly applicable to any shunting movement or, for that matter, to any other movement (wrong-road running, protected running, etc.).

Figure 6 shows a shunting movement of the length LBE from No. 3 Road to No. 5 Road via No. 14 points. The movement consists of two parts.

Let us first study the first part of that movement, from No. 3 Road to beyond No. 14 points.

It may be assumed that the time-distance curve of the first axle of the shunting movement has been determined empirically as a function of the length of the rake, the motive power unit used, the normal shunting speed, and the length of the route. This movement is shown as figure 6 *b*, which also shows the sections of the route from the stopping point H 3 onwards (fig. 6 *a*).

The movement begins at H 3 at zero time, and the first axle arrives on track section 10 after a time T_{10}. This time is marked as 10 on the blocking time strip representing the shunting movement R 3 - 14 - 5, corresponding to the number 10 of the track section reached. From this point,

the first axle continues until section 11 is reached. Here again, the time T_{11} determined with the aid of the time-distance graph is transferred transversely to the blocking time strip and marked by the figure 11 of the corresponding track section.

of the last axle are then followed in a similar manner to indicate the gradual release of the route. For this purpose, it is necessary to use the time-distance graph of the rear axle (fig. 6 *a*) the shape of which is obviously wholly identical with that of the front axle,

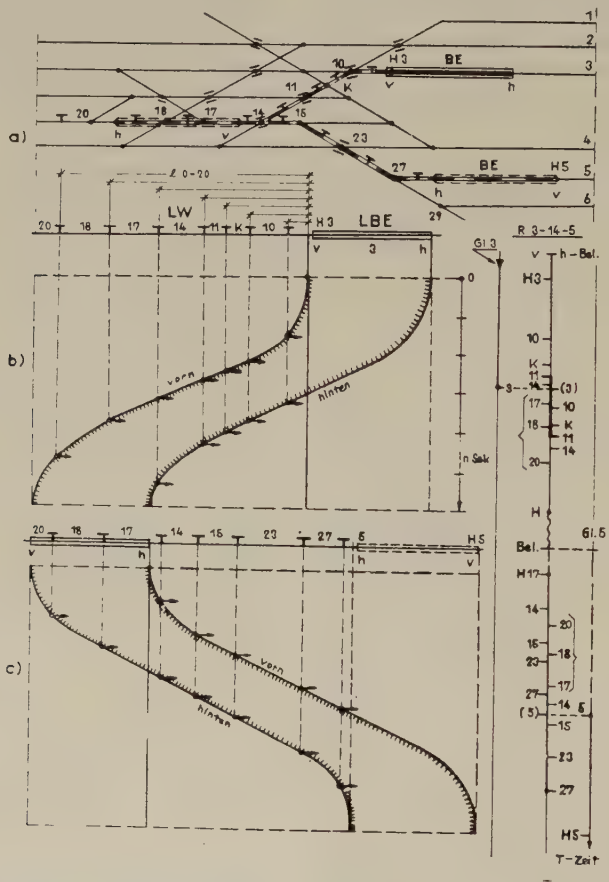


Fig. 6. — Time-distance curves and time strip for a shunting movement.

N. B. — Vorn = front. — Hinten = rear. — T-Zeit = time T.

The shunting movement proceeds to sections 14, 17, 18 and, eventually, 20. As before, the corresponding times are transferred to the blocking time strip (on the left side of it, marked by the index « v », indicating the front axle). The movements being simply shifted transversely by the length of the shunting rake.

Just as the track occupation of the front axle was recorded, the release of the different sections by the rear axle is marked on the blocking time strip of this shunting move-

ment (on the right-hand side of the time axis, marked by the index « h », indicating the rear axle). In this way, the whole of the shunting movement from No. 3 Road to beyond No. 14 points is clearly indicated on the blocking time strip, showing the track sections used and the times at which their occupation begins and ends.

track section, e.g. section 11, at what time the blockage « Bel » takes place, at what time the section is occupied by the first axle, and at what time it is released by the last axle, i.e. at what time the section again becomes available for other movements.

The conditions are exactly the same for a movement in the opposite direction. Here

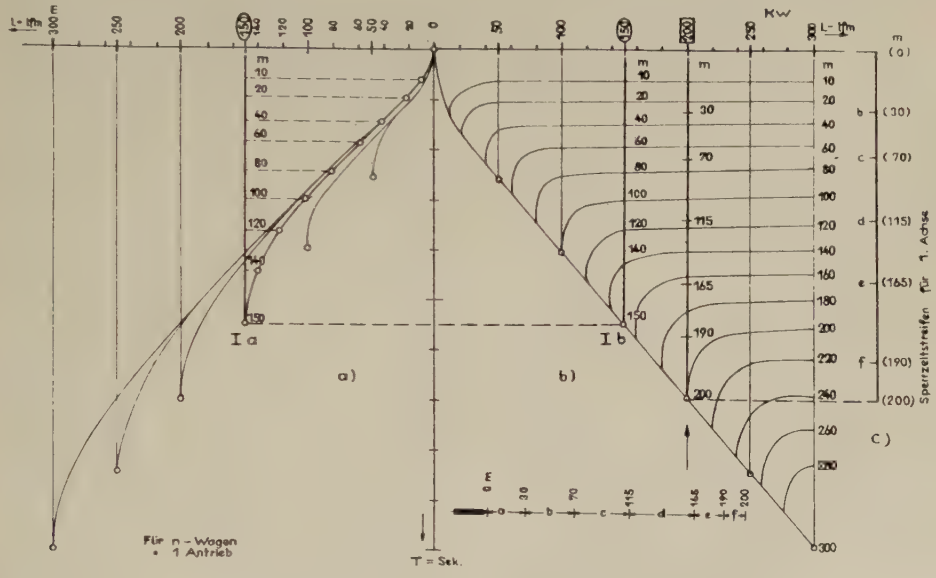


Fig. 7. — Time-distance curves for shunting movements.

N. B. — Sperrzeitstreifen... = blocking time strip for the first axle. — Für *n* Wagen... = for *n* vehicles and one motive power unit.

Thus, after the whole of the route on the blocking time strip has been blocked at the moment « Bel », the first axle of the shunting rake uses successively, from the moment of departure from H 3, the sections 10, K_1, 11, 14, 17, 18 and 20 (shown on the left-hand side of the time axis). The blocked sections are released under the same conditions (shown on the right-hand side of the time axis) in the sequence 3, 10, K_1, 11 and 14. The release of section 3 has here been recorded on the special strip indicating the blocking times of the platform roads. Sections 17, 18 and 20 are only released in the course of the return shunting movement. It is therefore possible to ascertain for each

again, the time-distance graphs of the front axle and rear axle during the new movement to No. 5 Road (the distance is assumed here to be longer) permit the completion of the contiguous blocking time strips. It will be seen, for example, that the sections used for the return movement, 17, 18 and 20, are released in reverse order.

Finally, the blocking of No. 5 platform road and its occupation by the first axle is noted. No. 5 Road will of course only be released as a result of another movement.

The blocking time line, occupied by a blocking time strip for a connection of points, is then released quickly for other blockings.

The blocking time strip for the shunting movement here chosen as example is based, as is shown in figure 6, on a time-distance graph for the shunting distance envisaged, taking into account the length of the rake, the power and braking characteristics of the motive power unit, and, of course, the normal driving habits.

In fact, the time-distance graphs required for the calculation of the capacity of an entire station are greatly variegated, as the basic conditions are apt to vary greatly.

But these different time-distance graphs may well be represented, as in figure 7, by a family of curves from which it is possible to transfer direct to the blocking time strip the periods of the blocking times of intermediate points or sections for any given shunting distance.

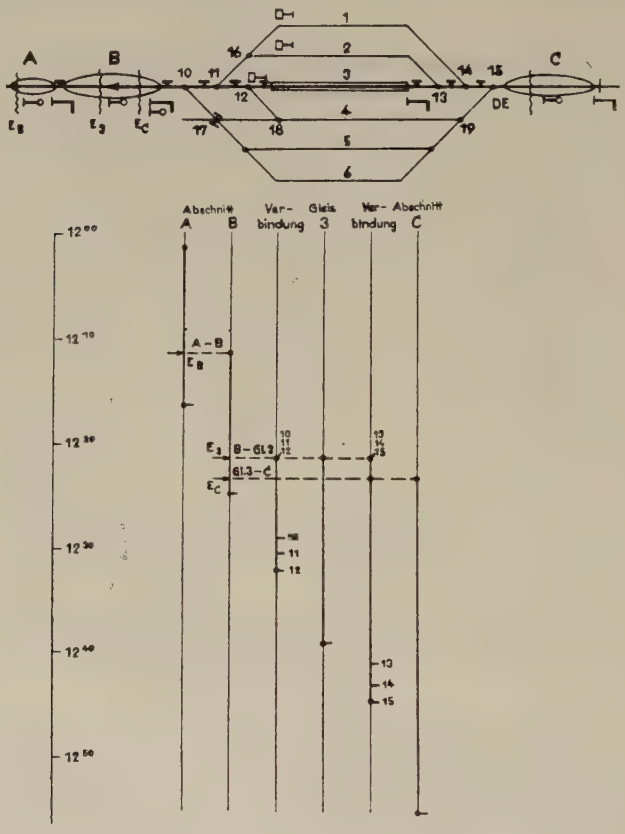


Fig. 8. — As figure 4, but simplified.

N. B. — Abschnitt = section. — Gleis = track. — Verbindung = connection.

These curves are plotted on several sheets, each corresponding to a given power class of motive power unit and a given group of vehicles, e.g. 1 to 3 wagons, or 4 to 6 wagons, etc. Details of such classification must be studied specially.

On the left-hand side of figure 7 (fig. 7 *a*),

several time-distance curves for shunting distances of 50, 100, 150 m, etc. up to 300 m have been plotted.

By way of example, the time-distance curve for a shunting distance of 150 m has been specially brought out. On the time axis, plotted below the abscissa point of 150 m, one has marked the times corresponding to part-sections of 20 m, determined with the aid of the time-distance graph; the figures, however, indicate the distances in metres. The blocking strip I_a of figure 7 *a* is transferred to the right (fig. 7 *b*) to the distance point of 150 m (strip I_b).

Similarly, the time-distance strips for the other intermediate stages are transferred from figure 7 *a* to figure 7 *b*.

By combining the points corresponding to the distances of 10, 20, 40, 60, 80, 100 m, etc. on the different time strips (classified by shunting distances), one obtains a family of curves which shows, for any shunting distance selected, on the time axis plotted below, the times for the distance range of the part-sections.

For instance, if it is desired to find, for a total shunting distance of 200 m, the blocking time strip showing the blocking times of the first axle on the part-sections *a* to *f* (fig. 7 *b*, bottom), it is sufficient to project the time-distance scale plotted below the value 200 (fig. 7 *b*) on the blocking time strip on the right-hand side.

After a distance of 30 m, section *b* is entered. After another 40 m, i.e. 70 m altogether, section *c* is reached. It is therefore possible to inscribe the indications of section *b* and *c* direct on the blocking time strip (to the left of the time axis for the first axle) opposite the distance marks 30 and 70 m interpolated on the time axis plotted below point 200 m of the family of curves (fig. 7 *b*).

The blocking times of the other sections, i.e. *d*, *e* and *f*, are similarly determined and marked.

The same families of curves serve, in the same way, to follow the times of the last axle, i.e. the times at which the sections are released, marked on the right-hand side of the blocking time strip.

One is thus in possession of all the data required to study, in a precise, clear and relatively simple manner, the capacity of complicated railway installations. The duration of the blocking time of the track installations can be easily varied and assessed by tracing the blocking time strips on movable paper strips.

The method offers the following advantages :

1. Line capacity and station capacity can be determined by identical means.

2. All the movements (train movements, shunting movements, protected movements, wrong-road movements) can be taken into account.

3. It is possible to take into account the length of the rake as well as the power of the motive power unit and the manner of driving.

4. It is possible to take into account partial releases of routes of the kind encountered with all-electric signalling installations.

In practice, one might forgo the reference to the first axle since, basically, the only relevant point in time is the moment at which a track section begins to be blocked, which is governed by the setting up of the route, it being understood that all the part-sections of the route are blocked at the same time.

Conditions are quite different for the last axle which causes the section to be released and which may entail partial releases. It will therefore only be necessary to use the data to be inscribed on the right-hand side of the blocking time strip so that the method is simplified still further.

It follows that the blocking times shown in figure 4 for the passing of a station can be simplified still further so that one obtains a very clear representation of the same problem, as shown in figure 8.

[625 .22]

The transverse dimensions of long railway vehicles,

by Abteilungspräsident Dr.-Ing. Adolf Mielich, Minden (Westphalia).

(*Glasers Annalen*, No. 7, July 1958.)

1. Past development.

The capacity of railway vehicles in terms of passengers or goods is largely dependent on their width. Admittedly, in contrast to road vehicles, there is the possibility of compensating for the lack of width by building longer vehicles or running longer trains, but there are naturally also limits to that. Widths, as well as heights, of the vehicles are governed by the vehicle gauge specified in the « Technical Unity » which has been adopted, with legal force, in most European countries, with the exception of Spain, Portugal and Russia. Apart from this international convention, many countries have got their own domestic vehicle gauge standards. In Germany, for instance, a slightly greater height of vehicles is permitted. The vehicle gauge standards applicable to Central Europe have already reached the venerable age of a hundred years and bear witness to the foresight of the railway engineers of their time who succeeded in planning a century ahead, although the vehicles of their time were still far from utilizing the potentialities of the vehicle gauge to the full. Yet the question arises whether the railway engineers of to-day can still rest content with the work of their predecessors. As a result of the development which has meanwhile taken place, the vehicle gauge specifications are now felt to be restrictive, and are hardly any longer adequate for goods as well as passenger vehicles. Recognizing the position, the German Railways have, for the last thirty years, adopted the policy of enlarging the distance between the running lines of doubletrack railways from 3 500 to 4 000 mm. This work, though otherwise far advanced already, is now reaching the stage where expensive alterations to bridges, tunnels or other bottlenecks have to be undertaken.

The problems encountered in this connection have already been the subject of a publication in 1944, investigating the possibilities of introducing, at reasonable costs, vehicles of greater width which can be used freely on a network of European railways (1).

Without wishing to deal here with this problem as a whole, it is proposed, in the following, to set out a proposal which will, even now, entail certain improvements as regards the tranverse dimensions of long vehicles.

It is well known that the width of 3 150 mm laid down in the « vehicle gauge » also applies to curved track with curve radii down to 250 m. It is only with even smaller radii that the obstruction gauge limit, and thus the space available for the width of the vehicle, is widened. Actually, according to the formulas at present in force, the width of a vehicle may, in a curve of less than 250 m radius, exceed the standard width of the vehicle gauge by $k = 75$ mm whilst, on the other hand, the vehicle gauge width on straight track may be narrowed by 25 mm, which amounts to the same as the widening of the gauge in curved track. However, there still remains this drawback that, as the length of the vehicles increases, their width must be more

(1) Mielich : « Möglichkeiten der Weiterentwicklung des Eisenbahnwesens vom Wagenbau aus gesehen » (« Potentialities of further railway developments, from the vehicle designer's point of view »). Periodical « Transit », No. 8, 1944.

and more restricted because of their chordal position within the obstruction gauge channel, unless it is possible to widen the obstruction gauge limit also in curves with a radius of 250 m or more, as a function of this radius.

In this connection, it may be mentioned in passing that, e.g., the Swedish railways provide for such widening in curves so that there is no restriction in width for long vehicles up to a bogie centre distance of 20 m. Russia, with a standard track gauge no more than 90 mm wider than the European standard gauge, has already adopted a vehicle width of 3.9 m, and those countries of the Eastern block where the track gauge conforms to the European standard are also likely to proceed with a certain increase of the permissible width of vehicles in order to enable Russian vehicles to run over their systems. As their railways are predominantly single-track and the number of engineering structures is comparatively small, this measure can of course be carried out more easily in those countries than in Central and Western Europe.

2. Suggestion for varying the bolster side play as a function of the curvature.

It is common knowledge that four-axled bogie type passenger coaches are nearly always fitted with pendular suspension so that they can move sidewise on the bogies. This arrangement, known as bolster side play, is necessary in order to mitigate, through the pendular motion of the coach body, abrupt transverse movements of the bogies due to faulty track alignment in curved and straight track. On poor track, a greater play would be necessary than on good track. However, for the reasons already indicated, and also to improve the riding quality, modern passenger coaches have now become so long that their width is already about 300 mm short of the permissible vehicle gauge. In the circumstances, every millimetre of car width becomes significant. On good track, a bolster play of 20 mm to either side would be just adequate. Unfortunately, however, the quality of the track, even on main lines used by long-distance expresses, is not yet always as good as it should be, and this bolster play is not sufficient in curved track where, as is well known, a transverse acceleration of 0.65 m/sec^2 is normally admitted (in France even up to 1 m/sec.) The bolster, having exhausted the full side play available, will simply remain in contact with the check plates, and the coach will pass through the curve as if the bolster were non-existent. International trials have shown that it is highly desirable to provide a bolster play of 50 mm in curved track if this disadvantage is to be avoided. With conventional vehicle designs, however, this would call for a further decrease of the coach width by $2 \times 30 = 60$ mm, a measure which, in view of the already greatly restricted width conditions inside the coaches, could not be accepted. But as the large bolster play of 50 mm will mainly be needed in curved track, and even there only on the outside of the curve, the following idea has arisen :

The bolster play is made dependent on the rotation of the bogie below the coach body, and thus on the curvature of the track, in such a way that, in curves of 250 m radius, a side play of 50 mm is available on the outside of the curve. For this purpose, the overhanging parts of the coach must be reduced in width in accordance with the « E_a » formula (1) discussed below, i.e. the coach body would have to be laterally contracted in the overhanging parts; alternatively, door handles, commode handles etc. would have to be recessed. At the same time, in order to obviate the need for narrowing the coach body, the play on the inside of a 250 m curve, « E_i», must amount to 20 mm, which would be perfectly sufficient since the coach, due to the nearly always active centrigufal force, will swing to the outside of the curve. In practice, this would mean that the vehicle would have a play, on straight track, of about 35 mm on either side,

(1) « Hütte », Vol. VB, page 190, 28th edition, published by Verlag Ernst & Sohn, Berlin; « Technical Unity », 1938, Article III, para. 6, 2 b.

which is permissible and is also adequate in nearly all cases of poor trackage. If, e.g. by providing skew contact surfaces between bogie and coach body, the rotation of the bogie below the body in a curve of 250 m radius would cause the skew contact surfaces on one side to come closer and thus to reduce the play by 15 mm, whilst the distance of the contact surfaces on the other side of the vehicle would be correspondingly increased by the same amount, one would obtain the desired side play without any part of the vehicle exceeding the permissible limits. These conditions are shown schematically in figure 1. The enlargement and reduction of the play can of course also be obtained by other means as long as it is dependent on the rotation of the bogie below the coach body, and thus on the curvature of the track. In this connection, there need be no misgivings that the vehicle gauge limit might be exceeded in curved tracks with a radius ranging from 250 m to ∞ (straight track) since the space conditions within the gauge channel improve, with increasing curve radius, more rapidly than the bolster side play on the inside of the curve increases. In curves with less than 250 m radius, on the other hand, the side play might either be allowed to become even greater than 50 mm, or might be limited to 50 mm. The play on the inside of the curve could be reduced still further, reaching zero in curves of approx. 90 m radius. But here again, it is desirable to keep the play constant with radii smaller than 250 m, by means of a suitable design of the check plates. As already mentioned, the speed limit in all curves is governed by a maximum transverse acceleration of 0.65 m/sec^2 so that, even in very sharp curves, there is no need for the side play to exceed 50 mm.

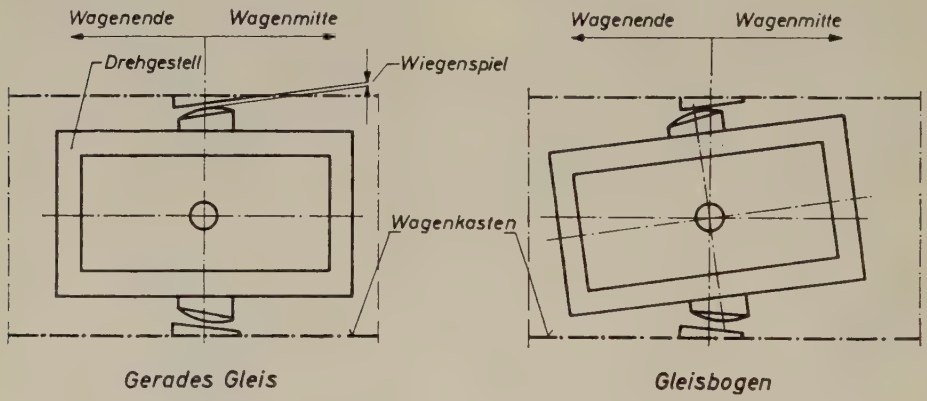


Fig. 1. — Bolster side play, dependent on the curve radius (basic diagram).

N. B. — Gerades Gleis = straight track. — Gleisbogen = curved track. — Wagenende = end of vehicle. — Wagenmitte = centre of vehicle. — Wiegenspiel = bolster play. — Drehgestell = bogie. — Wagenkasten = coach body.

3. **Modification of the width restriction formulas.**

The conventional formulas governing the width restriction of railway vehicles ([2]), viz.

$$E_i = \frac{an - n^2}{2R} + \frac{l - d}{2} + q + w + \frac{p^2}{8R} - k$$

and

$$E_a = \frac{an + n^2}{2R} + \left(\frac{l - d}{2} + q + w\right) \frac{2n + a}{a} - \frac{p^2}{8R} - k$$

are based on the assumption that the vehicle has, on either side, a constant bolster side play w. If this condition is modified as suggested above so that the play becomes a function of the track curvature and differs for E_i and E_a, respectively, w_i being the play on the inside of the curve and w_a that on the outside, the two formulas must be written as follows :

$$E_i = \frac{an - n^2}{2R} + \frac{l - d}{2} + q + w_1 + \frac{p^2}{8R} - k$$

and

$$E_a = \frac{an + n^2}{2R} + \left(\frac{l - d}{2} + q + w_a\right) \cdot \frac{n+a}{a} + \left(\frac{l-d}{2} + q + w_1\right) \cdot \frac{n}{a} - \frac{p^2}{8R} - k$$

4. **Results of trials with variable bolster side play.**

To begin with, the German Federal Railways have fitted the new type of bolster arrangement to a corridor coach of 26.4 m length, 2 815 mm width, and 19 m bogie centre distance. Since the overhanging parts of the coaches are already largely designed for a bolster play of 50 mm because the need for a greater play had already been recognized some time ago, it was merely necessary to replace the door handles and the external commode handles by those of slightly more compact design and to retract the lower step by a few millimetres. Bogies and coach body were fitted with the skew contact surfaces referred to above after the existing contact surfaces had been removed or adjusted for a maximum play of 50 mm. The bolster shock absorbers, mounted obliquely in the vertical transverse plane, hardly allow for the greater play; in future, they will be so constructed that no difficulties will be encountered even at maximum load and maximum bolster swing, allowing for possible inaccuracies. The arrangement is shown in figure 2. The play for the outward deviation is provided on the inside of the curve, and vice versa.

This vehicle has been used for a number of trial runs on straight track and on lines with many curves, first with the old bolster play of 2 × 20 mm (increased to 25 mm when the rubber buffers are compressed by the centrifugal force), and then with the new bolster play, amounting to 50 mm on the outside and 20 mm on the inside of the curves of 250 m radius and to 2 × 35 mm on straight track.

It is only natural, and has already been mentioned, that the larger play will have no obvious influence on the improvement of the transverse horizontal riding quality of the vehicle where the permanent way is good. But the position is different for poorer track, and in curves. Here it is permissible to expect a rather significant increase in the « riding quality index »

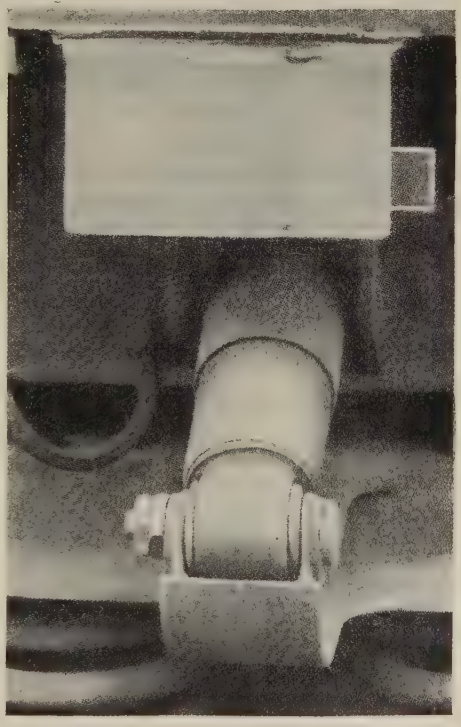
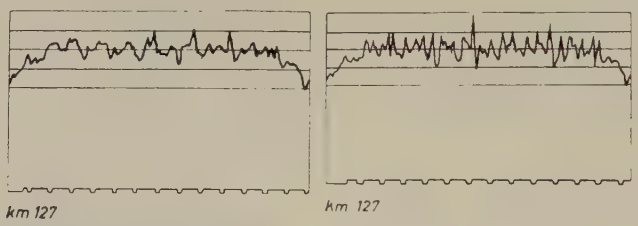


Fig. 2. — Check plate mounted on the coach body above the bolster shock absorber.

for the horizontal riding quality, W_z, of the order of 0.2 to 0.3 W_z. In particular, the peak acceleratons usually encountered at defects in the track are eliminated.

By way of example, figure 3 shows two sections from the accelerometer recordings on a track of medium quality, lying in a curve of 565 m radius with a superelevation of 100 mm. At a running speed of 105 km/h the residual transverse acceleration amounts to 0.85 m/sec^2, yet the bolster had obviously not reached the contact position. In normal operation, the maximum transverse acceleration permissible on the German Federal Railways is 0.65 m/sec^2.

In view of these advantages of the increased bolster play, it is intended to equip all the 26.4 m long corridor coaches of the German Federal Railways with this device in future. Even the reconstruction of existing coaches does not give rise to difficulties. The advantage of this device is particularly marked in the case of long vehicles.



Normal bolster play Variable bolster play 2 × 20/50 mm.

Fig. 3. — Horizontal transverse riding quality when negotiating a curved track of medium quality at a running speed of 105 km/h.

Summary.

Adequate bolster side play helps to secure sufficiently smooth running even on poor track. With vehicles of conventional design, however, this cannot be achieved without an undesirable reduction in the width of the vehicle. The author therefore describes a new design where this difficulty is partly overcome. The advantages are demonstrated on the strength of trial run results.

[385 (06 .111]

OFFICIAL INFORMATION

ISSUED BY THE

PERMANENT COMMISSION

OF THE

International Railway Congress Association.

Meeting of the Permanent Commission, held on the 12th March 1960.

The Permanent Commission of the International Railway Congress Association held a meeting on March 12, 1960, at 3 p.m., in the Belgian National Railways Headquarters Offices at Brussels.

* * *

Mr. De Vos, *President*, opening the meeting, addressed a warm welcome to the personalities present. Then, he requested the Assembly to approve the Minutes of the last session held in New Delhi, on December 7, 1959.

* * *

The *President* announced with deep regret the death of Mr. E. Vanderborght, former Operating Manager of the Belgian National Railways and member of the Permanent Commission from 1948 to 1951, and also of Mr. P.C. Mukerjee, former Chairman, Railway Board of the Indian Railways and member of the Permanent Commission from 1957 to 1959.

Mr. Ghilain, *General Secretary*, stated that Mr. A. Cuttica, « Directeur Général Adjoint et Conseiller d'Administration », Italian State Railways, and Mr. E. Roscioni, « Inspecteur Général Supérieur de la Motorisation Civile et des Transports », Ministry of Transport, Italy, have retired; furthermore, Mr. P. Giobbe, « Directeur du Service du Personnel et des Affaires Générales », Italian State Railways, will retire in the very near future.

Following a proposal introduced by the Italian delegation, the written ballot prescribed by Art. 6 of the Rules and Regulations has been made in order to extend the mandate of these personalities up to the next Congress.

The *President* announced in addition that Mr. G. Olivier, who was « Administrateur pour l'achèvement de la Jonction Nord-Midi » and former Deputy General Manager of the Belgian National Railways, has ceased his functions and his successor on the Permanent Commission will be designated in the near future.

He advised also the Assembly of a decision of the Executive Committee to nominate Mr. R. Squilbin, Senior

Engineer of the Belgian National Railways and Technical Secretary of the Association, as Assistant to the General Secretary. (*Approved*).

The complete list of the Members of the Permanent Commission is given in Appendix.

* * *

Mr. GHILAIN, reporting on the organisation of the next *Enlarged Meeting of the Permanent Commission* to be held on the occasion of the 75th Anniversary of the Association, stated that the Special Commission, constituted for this purpose, met again on February 22 last, in order to take the final decisions concerning this Session. The latter will be held from Monday June 27 to Wednesday June 29. The three following days will be devoted to technical visits and excursions.

The inaugural meeting will take place at the « Palais des Congrès » as well as the technical meetings of one of the three sections. The two other sections will meet at the « Hôtel Ravenstein », just opposite the « Palais des Congrès ». A brochure-programme containing all useful information will be sent in the near future to all the participants, who will receive also a membership card to be used as free-pass on the Belgian National Railways and on the National Light Railways Company.

Furthermore, a series of three railway stamps commemorating the 75th Anniversary of the Association will be given to the participants.

* * *

Then Prof. Dr. Jur. H.M. OEFTERING, *First President of the Deutsche Bundesbahn*, declared to the Assembly that the German Federal Railway was greatly honoured to have the opportunity to welcome the Congress in 1962. The session will be held at Munich (Deutsches Museum) from June 25 to July 3 or 4, 1962, and everything will be done so that this Congress will be worthy of the previous Sessions.

Mr. OEFTERING, supported by Mr. GUIBERT, *Deputy General Manager of the French National Railways*, suggested also to devote during the Congresses some more time to make known to the public the Association and its aims and to touch certain interesting topics by means of lectures given by specialists.

The *General Secretary* proposed that 10 questions should be put on the agenda of the 1962 Congress. Proposals will therefore be asked for as soon as possible to the affiliated Railway Administrations and Governments; they will be examined at the Brussels Enlarged Meeting at the same time than the allocation of the reporters between the different countries. (*Adopted*).

Mr. GHILAIN stated to the Assembly that the Sub-Committee constituted by Mr. DE VOS, Sir JOHN BENSTEAD and Mr. CREM, and entrusted to suggest a new title for Section 5, has decided to propose the following wording :

« *COMPLEMENTARY AND SUBSTITUTE SERVICES* ».

It has defined as follows, the matters relative to this Section :

1) Operation of branch and secondary lines where traffic is light.

2) Organisation, use and operating economics of road transport (passenger and freight) for such services.

3) Study of types of specialised vehicles and equipment for rail/road transport (excluding technical questions relative to the power unit, chassis and running gear).

The French translation of the title will be :

« SERVICE DE COMPLÉMENT ET DE SUBSTITUTION ».

After a comment made by Mr. UPMARK, *General Manager of the Swedish State Railways*, which gave rise to an exchange of views, the proposed title and definition were adopted.

* * *

The Assembly examined the report of the Auditors entrusted with the auditing of the accounts of the XVIIth. Session, including the financial years 1954 to 1958.

This report is favourable and consequently the accounts were approved without any comments.

* * *

The accounts (receipts and expenditures) for the financial year 1959 were approved by the Meeting. With regard to the budget for 1960 and the following years, the *General Secretary* recalled that the variable contribution, which amounted to 0.28 Gold-franc for the years 1954-1955 and 1956, had been reduced by 50% during the years 1957, 1958 and 1959 as sufficient reserve funds were available.

These reserve funds are now exhausted and the normal resources are no more sufficient to cover the management of the services of the Association. It appears therefore necessary to modify the amount of the reduction of 50% applied for the last three years to the variable part of the subscription. This point will be examined by the Permanent Commission at the next Brussels Enlarged Meeting; it will be the subject of a full report.

No resignation or new affiliation was recorded since the last session, therefore the Association include 34 Governments, 10 Organisations and 101 Railway Administrations with a total mileage of 601 705 km (373 000 miles approx.).

* * *

The meeting ended by the examination of the activities of the Library and Advertising Department of the Association.

The session was closed at 4.45 p.m.

The General Secretary, (s) P. GHILAIN. *The President*, (s) M. DE VOS.

List of Members of the Permanent Commission

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(MARCH 12, 1960.)

President :

M. **De Vos** (1), Directeur Général de la Société Nationale des Chemins de fer belges; 19, rue du Beau-Site, Bruxelles.

Vice-Presidents :

J. **Goursat** (2), Directeur de la Région du Nord de la Société Nationale des Chemins de fer français; 18, rue de Dunkerque, Paris (X[e]);

M. **Crem** (2), Directeur du Service de l'Exploitation de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles.

Members of the Executive Committee :

E. **Dorges** (1), Secrétaire Général Honoraire aux Travaux Publics et aux Transports, Délégué Général aux Affaires Internationales du Ministère des Travaux Publics, des Transports et du Tourisme; 244, boulevard Saint-Germain, Paris;

Sir John **Benstead** (2), Deputy Chairman of the British Transport Commission; 222, Marylebone Road, London, N.W.1;

Sir James **Dunnett** (3), Permanent Secretary, Ministry of Transport (Great Britain); Berkeley Square House, Berkeley Square, London, W.1.

Ex-presidents of session, members ex-officio :

D[r] Ing. G. **di Raimondo**, Directeur Général des Chemins de fer italiens de l'Etat (*retired*); Rome;

Ibrahim Fahmy **Kerim**; Le Caire;

D[r] W. **Meile**, ancien Président de la Direction générale des Chemins de fer fédéraux suisses; Brügglerweg, 11, Berne;

A. **Plana**, Sous-Secrétaire d'Etat aux Travaux Publics et Président du Conseil d'Administration du Réseau National des Chemins de fer espagnols; Madrid.

General Sir Brian **Robertson**, Bart., G.C.B., G.B.E., K.C.M.G., K.C.V.O., D.S.O., M.C., Chairman, British Transport Commission, 222, Marylebone Road, London, N.W.1.

Members :

E.T. **Aalto** (1), Directeur Général des Chemins de fer de l'Etat de Finlande; Helsinki;

Mohamed **Afifi** (1), Directeur Général des Chemins de fer de la République d'Egypte; Le Caire.

Dr. C.S. **Andrews** (1), Chairman of the Coras Iompair Eireann; Kingsbridge Station, Dublin;

Abdel Moneim **Azmy** (1), Sous-Secrétaire d'Etat au Ministère des Communications d'Egypte; Le Caire;

Sir John **Benstead** (already named);

R. **Besnard** (3), Chef de Service adjoint au Directeur général des Chemins de fer et des Transports, Ministère des Travaux publics, des Transports et du Tourisme; 244, boulevard Saint-Germain, Paris;

David **Blee** (1), General Manager, London Midland Region, British Railways; Euston Station, London, N.W.1;

Ing. F. **Boomstra** (1), Ingénieur en Chef au Ministère des Transports et du Waterstaat; La Haye;

Dr. H. **Born** (2), Directeur de l'Union d'Entreprises Suisses de Transport; Bundesgasse 28, Berne;

Dr. L. **Branca** (1), Vice-Directeur Général des Chemins de fer italiens de l'Etat; Rome.

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(1) Retires at the 18th session.
(2) Retires at the 19th session.
(3) Retires at the 20th session.

A. **Brouckaert** (3), Directeur du Service du Matériel et des Achats de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles;

E. **Clarembaux** (1), Directeur du Service de la Voie de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles;

M. **Crem** (already named);

G. **Csanadi** (2), Premier Adjoint du Ministre des Communications et des Postes (Hongrie); Budapest;

Dr Ing. A. **Cuttica** (1), Directeur Général Adjoint et Conseiller d'Administration des Chemins de fer italiens de l'Etat (*retired*); Rome;

Ph. **Dargeou** (1), Directeur Général de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IXe);

J. **de Aguinaga** (3), Directeur Adjoint du Réseau National des Chemins de fer espagnols; Madrid;

E. **Derijckere** (3), Directeur du Service de l'Electricité et de la Signalisation de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles;

M. **De Vos** (already named);

M. **Dias Trigo** (2), Directeur des Services d'Exploitation et du Matériel de la Direction des Transports terrestres au Ministère des Communications du Portugal; Lisbonne;

Dr Ing. G. **di Raimondo** (already named);

E. **Dorges** (already named);

A.R. **Dunbar** (2), Manpower Adviser, British Transport Commission; 222, Marylebone Road, London N.W.1;

J.M. **Garcia-Lomas** (3), Vice-Président du Conseil d'Administration du Réseau National des Chemins de fer espagnols; Madrid;

H. **Geitmann** (1), Präsident der Deutschen Bundesbahn; Friedrich-Ebert-Anlage, 43-45, Frankfurt (Main);

Dr. Ing. P. **Giobbe** (1), Directeur du Service du Personnel et des Affaires Générales des Chemins de fer italiens de l'Etat; Rome;

J. **Goursat** (already named);

K.W.C. **Grand** (3), Member, British Transport Commission ; 222, Marylebone Road, London, N.W.1;

Dr H. **Gschwind** (3), Président de la Direction Générale des Chemins de fer fédéraux suisses; Berne;

R. **Guibert** (3), Directeur Général Adjoint de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IXe);

F. **Hebert** (3), Directeur Général Adjoint de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IXe);

R. **Hoens** (2), Directeur Général de la Société Nationale belge des Chemins de fer vicinaux; 14, rue de la Science, Bruxelles;

I.A. **Ivanov** (2), Candidat des Sciences Techniques, Directeur de l'Institut Scientifique des Chemins de fer de l'U.R.S.S.; Moscou;

M. **Jacobshagen** (3), Ministerialdirektor, Leiter der Betriebsabteilung in der Hauptverwaltung der Deutschen Bundesbahn; Friedrich-Ebert-Anlage, 43-45, Frankfurt (Main);

Ibrahim Fahmy **Kerim** (already named);

Dr. Ing. Moustapha **Khalil** (2), Ministre des Communications d'Egypte; Le Caire;

A. **Kriz** (1), Ingénieur, Conseiller Supérieur de Section au Ministère des Communications de la République tchécoslovaque; Prague;

R. **Kunz** (3), Directeur de l'Office fédéral des transports; Berne;

Dr N. **Laloni** (2), ancien Directeur Général Adjoint des Chemins de fer italiens de l'Etat; Rome;

Brig. Ch.A. **Langley** (3), Chief Inspecting Officer of Railways, Ministry of Transport, Berkeley Square House, Berkeley Square, London, W.1;

J. **Lohmann** (2), Président des Chemins de fer Néerlandais, S.A.; Utrecht;

D.P. **Loomis** (1), President, Association of American Railroads; Transportation Building, Washington, 6. D.C.;

P. **Lorenzo Ochando** (3), Director General de Ferrocarriles, Tranvias y Transportes por Carretera; Madrid;

(1) Retires at the 18th session.
(2) Retires at the 19th session.
(3) Retires at the 20th session.

W.H. **Maass** (1), Advisory Engineer to the High Commissioner for the Union of South Africa; South Africa House, Trafalgar Square, London, W.C.2.;

L.T. **Madnani** (3), Railway Adviser to the High Commissioner for India in London; Government Building, Bromyard Avenue, Acton, London, W.3.;

M. **Malderez** (3), Secrétaire Général du Ministère des Communications de Belgique; 17 *a*, rue de la Loi, Bruxelles;

R.F. **Marriott** (2), Advisory Engineer, Representative of the New Zealand Government Railways, New Zealand House; 415, Strand, London, W.C.2;

K.B. **Mathur** (1), Chairman, Railway Board, Ministry of Railways, Government of India; New Delhi;

Dr W. **Meile** (already named);

Ing. Z. **Modlinski** (3), Sous-Secrétaire d'Etat au Ministère des Communications de Pologne; Varsovie;

J.P. **Musquar** (2), Directeur Général de la Société Nationale des Chemins de fer Luxembourgeois; 17, rue du Nord, Luxembourg;

P. **Nolet de Brauwere** (1), Secrétaire Général Honoraire de la Société Nationale des Chemins de fer belges; 121, avenue F. Lambeau, Bruxelles;

Prof. Dr. jur. H.M. **Oeftering** (2), Vorsitzer des Vorstandes und Erster Präsident der Deutschen Bundesbahn; Friedrich-Ebert-Anlage, 43-45, Frankfurt (Main);

A. **Plana** (already named);

J. **Puig Batet** (3), Directeur du Réseau National des Chemins de fer espagnols; Madrid;

J. **Ratter** (1), Member of the British Transport Commission; 222, Marylebone Road, London, N.W.1;

P. **Renaud** (1), Vice-Président du Conseil d'administration de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IX^{e});

Dr. Ing. S. **Rissone** (2), Directeur Général des Chemins de fer italiens de l'Etat; Rome;

General Sir Brian **Robertson** (already named);

Dr.-Ing. E. **Roscioni** (2), Inspecteur Général Supérieur de la Motorisation Civile et des Transports concédés au Ministère des Transports (Italie) (*retired*); Rome;

H. **Saito** (3), Directeur du Département Etranger aux Chemins de fer Nationaux du Japon; Chiyodaku Tokio;

Dj. **Savićevic** (3), Directeur Général Adjoint des Chemins de fer Yougoslaves; Belgrade;

Dr M. **Schantl** (1), Directeur Général des Chemins de fer fédéraux autrichiens; 9, Elisabethstrasse, Vienne I;

Dr. F. **Schelp** (1), Mitglied des Vorstandes und Präsident der Deutschen Bundesbahn; Friedrich-Ebert-Anlage, 43-45, Frankfurt (Main);

H.E. **Simpson** (2), President, Baltimore and Ohio Railroad Company; Baltimore, Md.;

P.E.N. **Skov** (1), Directeur Général des Chemins de fer de l'Etat danois; 40, Sölvgade, Copenhague, K;

R. **Soulard** (1), Directeur du Mouvement de la Société Nationale des Chemins de fer français; 8, rue de Londres; Paris (IX^{e});

H.E. **Stokke** (3), Directeur Général des Chemins de fer de l'Etat norvégien; Oslo;

J. **Tuja** (2), Secrétaire Général de l'Union internationale des Chemins de fer; 10, rue de Prony, Paris;

E.G.J. **Upmark** (3), Directeur Général des Chemins de fer de l'Etat suédois; Stockholm;

R. **Vaubourdolle** (3), Chef Adjoint des Installations Fixes de la Société Nationale des Chemins de fer français; 42, rue de Châteaudun, Paris;

F. Perez **Villamil** (3), Directeur Adjoint du Réseau National des Chemins de fer espagnols; Madrid;

W. **White** (1), President, Delaware & Hudson Railroad Corporation; 230, Park Avenue, New York 17;

O. **Wichser** (2), Directeur Général, Chef du Département des Travaux et de l'Exploitation des Chemins de fer Fédéraux Suisses; Berne;

Dr. Ing. W. **Wyrzykowski** (2), Vice-Directeur de l'Institut Scientifique des Essais et des Recherches Ferroviaires des Chemins de fer de l'Etat Polonais; Varsovie;

N..... (3) Argentina.
N..... (1) Argentina.
N..... (2) Belgium.
N..... (3) Bulgaria.
N..... (3) China.
N..... (1) Egypt.
N..... (3) Spain.
N..... (2) U.S.A.
N..... (3) Roumania.
N..... (3) Switzerland.

(1) Retires at the 18th session.
(2) Retires at the 19th session.
(3) Retires at the 20th session.

Honorary President : F.H. **Delory,** Directeur Général honoraire de la Société Nationale des Chemins de fer belges; 2, avenue Curé Glibert, Rixensart.

Members of Honour : L. **Armand,** ancien Président du Conseil d'administration de la Société Nationale des Chemins de fer français; 88, rne Saint-Lazare, Paris (IX^{e})

O.V.S. **Bulleid,** former Chief Mechanical Engineer, Coras Iompair Eireann, and former Chief Mechanical Engineer, Southern Region, British Railways; St. Anthony's Close, Belstone, Devon.

P. **Ghilain,** Directeur honoraire du Service du Matériel et des Achats de la Société Nationale des Chemins de fer belges, Secrétaire Général de l'Association; 19, rue du Beau-Site, Bruxelles.

Ranald J. **Harvey,** Consulting Engineer; 34, Victoria Street, Westminster, London, S.W.1.

The Rt. Hon. Lord **Hurcomb,** G.C.B., K.B.E., Chairman, British Transport Commission 1947-53; 47, Campden Hill Court, Campden Hill Road, Kensington, London W. 8.

U. **Lamalle,** Directeur Général honoraire de la Société Nationale des Chemins de fer belges, professeur émérite de l'Université de Louvain; 27, rue de l'Aurore, Bruxelles.

SECRETARY'S OFFICE : 19, rue du Beau-Site, Brussels.

General Secretary : **P. Ghilain** (already named).

Assistant to the General Secretary : **R. Squilbin,**
Senior Engineer, Belgian National Railways.

NEW BOOKS AND PUBLICATIONS.

[385 (08 (460)]

RED NACIONAL DE LOS FERROCARRILES ESPAÑOLES. — **Memoria del Consejo de Administración. Ejercicio de 1958.** (*R.E.N.F.E. Report of the Administrative Council. Year 1958*). A brochure (7 7/8 × 11 3/4 inches) of 94 pages with numerous tables.

During 1958 the increase in traffic on the R.E.N.F.E. did not proceed at the same rhythm as previously. Though there was an increase in the passenger traffic and fast goods traffic, the most important traffic, the slow goods traffic, remained unaltered: the number of passenger-km reached 8 730 millions in 1958 compared with 8 607 millions in 1957; with regard to the goods traffic, the ton-km in the case of the fast goods traffic rose from 244 millions to 257 millions, whilst in the case of the slow goods traffic, there was a slight decline from 7 640 millions to 7 622 millions.

Although in view of this the overall traffic only showed a slight increase, there was a much greater increase in the receipts because of the increased tariffs, which came into force in April 1957 and August 1958. The latter increase being greater than the increased costs, the operating deficit in 1958 was about 8 %, below that of 1957, and the operating coefficient was 119 % compared with 124 % in 1957.

The year 1958 was marked by considerable improvements in the train services, which is shown by an increase in the train-km and new facilities were offered to the public. Important work was also carried out in the field of the fixed installations, permanent way, bridges and signalling, and new traction stock, both steam, Diesel and electric as well as trailing rolling stock was purchased.

The electrification of the system continued with the putting into service in Catalona of 168 km of electrified lines; electrification work is also in hand on the Andalusian line, as well as on the old Galicia line.

The inauguration of the 98 km long section Carballino-Santiago marked the completion of the new Zamora-La Coruña line, 453 km long, which appreciably reduces the distance between Madrid and the important towns in the North-West of Spain. This new line, with its numerous bridges and particularly carefully studied layout, may be quoted as amongst the most remarkable technical realisations of the present day in the railway world.

Commenting on the large scale programmes now being carried out or under study, the report draws attention to the completion in the near future of the General Reconsruction Plan and stresses the advantage of following this up without any break by the Five Year Modernisation Plan, the carrying out of which is awaiting government authorization. It also stresses the normal development of the Economic Aid Programme within the framework of which is included a great deal of work on the permanent way and signalling.

The report ends with statistics concerning the economic position, the traffic, the personnel and the stock of the R.E.N.F.E.

R. S.

[**385** (08 (460)]

La Red Nacional de los Ferrocarriles Españoles en 1958. (*The R.E.N.F.E. in 1958*) A pamphlet (8 1/4 × 11 in.) of 32 pages, copiously illustrated.

Besides the Report of the Administrative Council, the Spanish Railways have published a pamphlet intended to have a wider appeal, which gives in a less official form the most characteristic data on the activities of the R.E.N.F.E. during 1958.

Here are discussed all the questions which may interest not only specialists in railway problems, but also a far more extensive public: the evolution of the receipts and costs, tariffs, the operating deficit and its causes, productivity, work on the permanent way, acquisition of stock, electrification.

In addition, this brochure deals in a very detailed fashion with the serious problem of rail-road competition. This problem, which preoccupies all Railway Administrations, is mentioned in the preface and the R.E.N.F.E. stresses the considerable evolution which has taken place in land transport, owing to the ever increasing intervention of road transport; it calls attention to the difficulties which the railway, subject as it is to rigid organic laws, meets when competing against this competitor, and expresses the wish that there might be some relaxation of certain regulations which were only justified when in fact the railway enjoyed a monopoly. Returning to this same point later on, the R.E.N.F.E. compares from all points of view the railway and road traffic and shows the economic value of developing the railway traffic.

Copiously illustrated with photographs showing the development of the railway in all fields, and with graphs which make it possible to follow the evolution of the working during the last few years, this document is a proof of the vitality of the R.E.N.F.E. and will doubtless achieve its objective: a better knowledge of the railway, its problems and its achievements.

R. S.

[**656** .28 (42)]

Brigadier C.A. LANGLEY, Chief Inspecting Officer of Railways, Ministry of Transport and Civil Aviation. — **Report to the Minister of Transport and Civil Aviation upon the Accidents which occurred on the Railways of Great Britain during the year 1958.** — A brochure (6 × 9 7/8 in.) of 74 pages, with tables and diagrams. — 1959, Her Majesty's Stationery Office, York House, Kingsway, London, W.C. 2 and 423, Oxford Street, London, W. 1. (Price : 4 sh. net.)

Continuing his series of annual report, Brigadier C. A. Langley has just published an analysis of the accidents which occurred during 1958 on the British Railways. There were 1 186 train accidents, i.e. 19 less than in 1957, which continues the trend towards fewer accidents which has been noted since 1950. Of this number, 223 occurred at level crossings (i.e. 21 more than in 1957), while there were 232 derailments (i.e. 18 more than in 1957). It will also be noted that 766 accidents (i.e. 65 %) were due to human error. In 15 cases, official enquiries were held. These various accidents resulted in 36 deaths, 111 seriously injured, and 1 058 slightly injured; the number of victims (1 205) was 131 more than in the previous year. One accident (Dagenham) was the cause of 10 deaths. These

36 victims can be divided up into 18 passengers, 5 employees and 13 third parties.

The report also deals with the 1 612 accidents in connection with the traffic and working, but not due to the trains, which were responsible for 7 026 victims. Amongst the 170 killed, 33 were passengers and 117 employees (this figure is the lowest recorded for many years; it must be stressed that it is due to the intensive propaganda on safety measures for the staff which has been made for some years). It should also be noted that no accidents were caused by contact with electrical conductors.

As regards « automatic stopping of the trains » [this British device has now been installed on nearly 2 000 locomotives over about 3 500 km (2 175 miles) of lines] such a system would have prevented 6 accidents, had it been installed. As the idea of automatic train control might give rise to confusion, the author of the report suggests that the equipment now used by British Railways should be called the « Automatic Warning System ».

P. SCH.

[**621** .3]

Lexikon der Hochfrequenz-, Nachrichten- und Elektrotechnik. Band IV. (*Dictionary of high frequency, telecommunications and electricity techniques*). — Volume IV (letters R to Z). — 852 pages, 498 figures and numerous tables. Imitation leather binding. Publishers : Curt RINT — Porta Verlag KG, Munich, and Verlag Technik, Berlin. (Price : 28.75 DM.)

We have already reviewed the Curt Rint Dictionary, an important work now brought to completion by the publication of the present volume IV.

With the collaboration of some forty specialists, this deals with such diverse fields as the technique of heavy currents, meteorology, astrophysics and photography.

More than 25 000 notions are carefully defined, each technical field having been covered by a specialist in this particular branch, which assures the accuracy of the definitions given.

Each of the notions dealt with, about which there is an explanatory text and bibliographical references, is accompanied by its translation into English, French and Russian.

In view of the success of this work right from the publication of the first volume, the publishers have decided to issue during 1960 a supplementary volume in the form of a dictionary giving in alphabetical order the English, French and Russian translations of the notions defined in the four volumes.

Those readers whose mother tongue is not German, will certainly await the publication of this dictionary with great interest.

F. B.

[**313 : 656** (494)]

Schweizerische Verkehrsstatistik *(Swiss transport statistics)*, **1958.** — One volume (8 1/4 × 11 3/4 in.) of 162 pages with 9 additional graphs. — 1959, Berne, published by the Federal Transport Office (Price : 12 Swiss francs).

The *Swiss Transport Statistics, 1958*, which the Federal Transport Office has just published, give, as is the practice for each year, very complete statistics about the activities of all Swiss transport undertakings.

As the 1957 report already announced, the

year 1958 confirmed a slight decline in the national economy, the effects of which were felt more especially by the goods traffic of the railways.

The year 1958 moreover saw the coming into force of the new law on the railways, which was a considerable help to the general railways from the following three points of view : indemnification by the Confederation for any charges occurred in favour of the general economy, possibility offered to the railways of improving their equipment, and the meeting of operating deficits by the Federal State and the Cantons.

The Federal Railways, whose operating coefficient stands at 89.2 %, recorded in 1958 a slight increase (1 %) in passenger traffic but a definite decline (6.9 %) in goods traffic.

The private railways show a similar evolution, viz a slight increase (1.2 %) in passenger traffic and an appreciable decline (9 %) in the tonnage of goods traffic carried. Their overall operating coefficient is 101.4 %.

The special railways once again saw an increase in their traffic, especially in the winter when this increase amounted to 22.5 % owing to the increase in popularity of skiing and the very favourable snow conditions lasting late into the season. The telphers, in particular, show an increase of 37 % in their traffic, taking into account the new installations put into service during 1958.

Urban transport gave rise to slightly higher receipts than those of the previous year (3.8 %). The year 1958 saw the continuance of the replacing of the tramway lines by trolleybus or omnibus services.

The report also gives detailed information about the position of the stock of road vehicles, as well as navigation on the lakes and rivers.

It ends with a chapter devoted to air transport, in which it is reported in particular that « Swissair » for the first time since its creation carried more than one million passengers.

R.S.

3rd. International Cybernetic Congress.

The International Association of Cybernetics will organise from the 11th to 15th September 1961, its 3rd International Cybernetic Congress, at Namur (Belgium).

The following subjects will be studied : Foundations and methods of cybernetics. - Semantic machines. - Automation : Technical aspects. - Automation : Economic and social aspect. - Cybernetics and life.

All those wishing to participate to this Congress are requested to apply to the Secretariat of the Association, 13, rue Basse-Marcelle, Namur (Belgium).

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